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The Soviet Atomic Bomb

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14. ABSTRACT
The first Soviet atomic device was detonated in August 1949, only four years after the American atomic bomb was exploded. The research project "The Soviet Atomic Bomb" is based on recent Russian publications on the subject showing how it was done. The scientific foundation of the project was outstanding research in nuclear physics performed in the Soviet Union before the war with Germany. After the American atomic bombs were exploded, the atomic project became national priority #1. In the centrally planned, state-owned economy Soviet leaders were able to concentrate all necessary resources, human, material, and financial, for the development and production of the atomic bomb in the shortest time possible. Hundreds and hundreds of research institutes, design bureaus, and production plants were engaged in the project. The Soviet intelligence supplied very valuable information about the American atomic bomb. The most important works were performed in a specially built secret city, closed from the outside world. New highly specialized industries were established. All was managed from the highest levels of the Soviet government bureaucracy under the constant supervision of Stalin himself.

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This research paper, The Soviet Atomic Bomb, is presented as a competent treatment of the subject, worthy of publication. The United States Air Force Academy vouches for the quality of the research, without necessarily endorsing the opinions and conclusions of the author. Therefore, the views expressed in this article are those of the author and do not reflect the official policy or position of the United States Air Force, Department of Defense, or the US Government.

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Alice J. Chen

ALICE J. CHEN, Lt Col, USAF
Director of Faculty Research

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FOREWORD

The Soviet atomic bomb test of 1949 was a revelation of major proportions for the United States, and began a new chapter in the long-term competition with the Soviet Union. “Containment” was originally conceived within a relatively benign environment. It was supposed to be a period of watchful restraint of Soviet expansionism for perhaps 15 years. Implicit in the original view was that the Soviets were about a decade away from a usable nuclear capability. Thus, the United States was expected to hold an exploitable nuclear monopoly during the bulk of the period when containment would be needed, and clear superiority for all of it. With the US having clear escalation dominance, containment would in practice be mostly a matter of diplomacy, economic reconstruction, and limited military actions. The 1949 test (at least five years too early for Western comfort) decisively proved those assumptions to be false. The Soviets had found a clearly effective response to the Anglo-American nuclear innovation, and had also raised the stakes in the Cold War.

This nuclear surprise, along with the communist victory in China (1949) and the North Korean invasion of South Korea (1950), caused a major policy review. Should “containment” be directed at communist regimes and movements, or just the Soviet Union. Should the policy apply throughout the world, or mostly in Europe. NSC-68 (1950) offered the first response to both; containment was to be directed against the entire communist movement, and executed worldwide.

The story about why the Soviets were successful, so dramatically and so soon, in acquiring a nuclear capability has been largely incomplete. This was unfortunate, since the project is worth serious study as a scientific research effort, an exercise in covert intelligence, and as an economic enterprise. Until recently, the scientific and economic dimensions were largely buried in classified Soviet archives. There has been a significant literature, and no small amount of controversy, about the intelligence aspects; however, Soviet use of nuclear intelligence and its significance in the overall project were also buried in classified archives. All that has, of course, changed over the past decade. With *glasnost* in the late 1980s and the demise of the USSR in 1991, the archives have been at least partially opened – and we know much more about the Soviet atomic bomb project. With the new information has come a new literature.

Professor Vladimir Shamberg, an economist, is uniquely qualified to contribute to this discussion. He has been a distinguished member of the Soviet academic community for the bulk of his professional life. He knows first hand how the Soviet system functioned. He also writes with the first-hand acquaintance of a number of the key individuals. He’s therefore superbly equipped to make the most of the new information. What’s appearing in open literature about the USSR (a) is not yet completely integrated and (b) is of variable reliability. Based on his personal and professional experience, Professor Shamberg can, and does, connect the separate views now published and sort out what’s genuine and useful.

The monograph that follows centers on the atomic bomb project as an economic enterprise in a centrally planned economy. The organization of the project and the incentives (both positive and negative) the participants faced make fascinating reading. As one who was a full-fledged practicing economist in the Soviet system, Professor Shamberg has unearthed a fascinating history of the cluster of enterprises that gave the USSR its nuclear capability. That in itself makes this piece highly worthwhile.

But there's more. What makes this work an especially important contribution is the interweaving of the scientific and intelligence dimensions with the history of the atomic enterprise. Professor Shamberg has provided what is perhaps the clearest statement of the entirety of the effort, in all its dimensions. What's particularly noteworthy is the extensive scientific and technical capabilities that were available within the country well before any country took the atomic bomb as a serious option.

This is perhaps a useful cautionary note as we consider the future of the Soviet military-industrial complex. Russian technology remains formidable today and the state still has the will to produce first-rate weapons. Hence, failure to consider past experience, such as the Soviet quest for an atomic bomb, may mean unpleasant surprises in the decades ahead.

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August 2000

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INTRODUCTION

On August 29, 1949 the Soviet Union detonated its first atomic device and became the world's second nuclear power. It drastically changed the balance of power in international relations.

The Soviet atomic device was detonated only four years after the United States exploded its first atomic bombs. It was a tremendous achievement for a country devastated by the most terrible war in its history, for a country with an industrial base inferior to its American counterpart. How was it done? Was there any impressive research in nuclear physics conducted in the country, which could be used by Soviet physicists? How was the development and production of atomic weapons organized? Where it was conducted? Who were the people – first of all, scientists and engineers – responsible for these tremendous achievements? What was the role of Soviet intelligence and materials obtained from the American atomic project and supplied to Soviet physicists?

After the American atomic bombs were exploded, the atomic project became the top priority on Stalin's agenda. He desperately wanted to have atomic weapons as soon as possible. Without atomic weapons he felt inferior, an object for American blackmail and even a possible nuclear strike. The Soviet atomic project got all the necessary resources, human, material, financial, and was under the constant supervision of Stalin and his closest aides. Everything about the work on atomic and hydrogen weapons was top secret. The books and articles about nuclear energy published in Soviet times pointedly avoided weapons and concentrated on theoretical aspects and peaceful uses of atomic energy. However, after the collapse of the Soviet Union very valuable monographs, articles, and memoirs written by people who participated in the project were published. At the same time, quite a few publications appeared which distorted or inaccurately reported the history of the development of nuclear weapons in the Soviet Union. In some of these publications, KGB spies, not scientists and engineers, are presented as the fathers of the first Soviet atomic bomb. In this paper, based on the latest and, in my view, the most reliable Russian publications, I try to provide an answer at least to some of the questions put forward above.

1. SOVIET PRE-WAR RESEARCH IN NUCLEAR PHYSICS

Becquerel's discovery of radioactivity in 1896 opened a new field of physics: nuclear physics. The pioneering discoveries and theoretical models of M. Sklodowskaya (Mme. Curie) and P. Curie, E. Rutherford, N. Bohr, G. Thompson, M. Planck, and many others made great contributions to its development.

Russian physicists participated in the rapid development of physics at the end of the Nineteenth and beginning of the Twentieth Century. They knew about their Western colleagues' work in nuclear physics and actively participated in the research in this new field. Research in radioactivity started in Russia shortly after Becquerel's discovery. It was undertaken at the University of St. Petersburg, at the Medical Academy, and at the Universities of Kharkov, Novorossiisk, and some others. Russian physicists worked at the laboratories of their Western colleagues and at laboratories in Russia and made their contributions to nuclear research. For example, V. Borodovski worked in England at the Kensington Laboratory, from 1908, and at the Cavendish Laboratory. He was one of the first to discover radium in radioactive ore from the Fergana Valley (Uzbekistan). G. N.Antonov worked for a number of years in Rutherford's laboratory. In 1911, he discovered Uranium Y (thorium-231). L. S. Kolovrat-Chervinski worked in M. Curie's laboratory for 5 years, from 1906. He researched characteristics of beta-rays and compiled "Tables of Constants of Radioactive Materials." In 1910, a radiological laboratory was established in Odessa (Ukraine), and shortly thereafter a radiological laboratory was opened in Tomsk (Siberia).[1] The participation of Russian physicists in the exploration of radium later permitted the creation of a Russian radium industry and development of medical radiology, which later played an important role in the nuclear project.

After the October Revolution of 1917, nuclear research was continued, but in a different setting. Science in Russia became state science. All research and teaching institutions became state-owned and state-financed. The Academy of Sciences and its research institutes were financed from the state budget. However, money available for financing science was very limited, and science was under-funded. Despite this, from the early 1920s research institutes were established which became very important centers of nuclear research. In 1918, the Petrograd State X-Ray and Radiology Institute was established. The Institute had Physical-Technical, Radium, Optical, and Medico-Biological Departments. Very soon these departments were transformed into separate institutes.

In 1922, the Radium Institute of the Academy of Sciences (RIAN, in its Russian abbreviation) was established. Its first director was the famous Russian scientist Vladimir A. Vernadskii. Vitali G. Khlopin was deputy director. In 1922, Academician Vernadskii prophetically stated: "We are approaching the great revolution in the life of mankind, with which cannot be compared all his past experience. The time is not far distant when man will hold in his hands atomic energy, the source of power which will make it

[1] A. M. Petrosy'ants, Atomistika i Ee Shagi v Istorii; In: *Ministerstvo Rossiiskoi Federatsii po Atomnoi Energii. Sozdanie Pervoi Sovetskoi Yadernoi Bomby*, V. N. Mikhailov – Editor-in-Chief [Mr. Mikhailov was Minister of Atomic Energy], A. M. Petrosy'ants – Deputy Editor-in Chief, (Moskva: Energoatomizdat, 1995), 20.

possible to build his life as he wishes. It may happen in the coming years, it may happen a century from now. But, it is obvious that it should happen. Scientists must not shut their eyes to the possible consequences of their scientific work, of scientific progress. They should realize their responsibility for the consequences of their discoveries. They should direct their work towards the better organization of all mankind."[2]

Among RIAN's noted scientists were researchers who later made great contributions to atomic and nuclear projects: V. G. Khlopin, B. A. Nikitin, B. P. Nikolsky, K. A. Petrzhak, A. P. Ratner, and others. From the beginning, RIAN concentrated on research on characteristics of radioactive materials, their distribution in the earth's crust, the technology of recovering uranium ore, nuclear physics, and radiochemistry. In 1922, the Institute's researchers, headed by V. G. Khlopin, were able to extract the first examples of radium from domestic ore. The experimental facilities developed at RIAN during the pre-war years were very good, maybe the best in Europe for research in nuclear physics and radiochemistry. The first cyclotron in Europe was built at RIAN. In March-June 1937, researchers used this cyclotron to produce an intense beam of 3.2-MeV protons. I. V. Kurchatov, M. G. Mesheryakov, A. I. Alikhanov, A. P. Vinogradov, and other researchers who later were at the top of the nuclear weapons project worked at this cyclotron facility.[3]

The Petrograd Physical-Technical Institute was established in 1923. The city of Petrograd was renamed Leningrad in January 1924, and the Institute became the Leningrad Physical-Technical Institute (LFTI, in its Russian abbreviation). The noted physicist Abram F. Ioffe was appointed the Institute's director. LFTI became the top research and educational school for Soviet physicists. Young physicists held Ioffe in special reverence; they called him "Papa Ioffe." Ioffe established a special seminar on nuclear physics at the Institute, and nuclear physics became one of the Institute's major research fields.[4] Ioffe made outstanding contributions to the development of Soviet nuclear physics. From the very beginning he wholeheartedly supported I. V. Kurchatov and A. I. Alikhanov when they suggested that research in nuclear physics should be started at the Institute. It was not easy; work in nuclear physics at that time was considered to be a theoretical exercise without any practical use. Nevertheless, in December 1932, Ioffe established the Department of Nuclear Physics at LFTI. Initially, Ioffe himself was chairman of this department and I. V. Kurchatov was his deputy. However, after half a year, Kurchatov was appointed chairman of the department; he very soon became the leading figure in Soviet nuclear research. LFTI produced top Soviet scientists engaged in theoretical and experimental nuclear research. Among the physicists at LFTI were scientists who later most actively participated in atomic and nuclear projects: A. P. Aleksandrov, A. I. Alikhanov, L. A. Artsimovich, I. K. Kikoyn, N. N. Semenov, D. V. Skobeltsyn, G. N. Flerov, Yu. B. Khariton, and others.[5]

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[2] Quoted in: A. M.Pertosy'ants, Atomistica I Ye Shagi V Istorii, "*Sozdanie…*"28; A. M. Petrosy'ants, *Problems of Nuclear Science and Technology. The Soviet Union as a World Nuclear Power* (Oxford, New York, Toronto: Pergamon Press, Fourth Edition, 1981), 6. [Translated from the Russian by W.E. Jones].
[3] A. K. Kruglov, *Kak Sozdavalas Atomnaya Promishlennost v SSSR* (Moskva: Tsniiatominform, 1995), 20; A.M. Petorosy'ants, Atomistika I Ye Shagi V Istorii, "*Sozdanie…,*" 29.
[4] Yu. B. Khariton, A. F. Ioffe i I. V. Kurchatov, "*Yulii Borisovich Khariton. Put Dlinniu v Vek*" (Moskva: Editorial UPSS, 1999), 75; *Atomnaya Otrasl Rossii. Sobitiya, Vzglyad v Budushee* (Moskva: IZDAT, 1998), 37.
[5] A. M. Petrosy'ants, Atomistika i Ee Shagi v Istorii, "Sozdanie…,"28.

In 1928 the Ukranian Physical-Technical Institute (UFTI) was established in Kharkov. Later, the Institute was renamed the Kharkov Physical-Technical Institute (KhFTI).[6] That same year, the Siberian Physical-Technical Institute was established in Tomsk.[7]

In 1931, the Institute of Chemical Physics of the Academy of Sciences (IKhF) was established in Leningrad. This Institute was organized by one of the originators of the Soviet school of chemical physics, N. N. Semenov, who became its director and was later awarded a Nobel Prize in chemistry. Semenov headed the Institute for many years and created a large school of disciples: Ya. B. Zeldovich, Yu. B. Khariton, and K. I. Shelkin among them.[8]

In 1932, the Physics Institute of the Academy of Sciences (FIAN) was founded in Leningrad. FIAN soon became a leading center of physical science. Very important theoretical and experimental research on the release and utilization of the energy of atomic nuclei was carried out at this Institute.

In the period 1932-1940, Soviet physicists participated very actively in the development of nuclear physics. In 1932, D. D. Ivanenko first proposed that the atomic nucleus consisted of protons and neutrons. Also in 1932, K. D. Sinelnikv, A. I. Leypunskii, A. K. Valter, K. D. Latyshev, repeated a development by G. Cockcroft and E. Walton, and built a cascade electrostatic generator at KhFTI; with it they accelerated hydrogen nuclei and accomplished the fission of lithium.[9] In 1932, G. A. Gamov published a monograph "The Structure of Nucleus and Radioactivity." It was the first attempt in the Soviet Union to interpret nuclear structure.[10]

A number of talented young Soviet physicists visited famous Western laboratories and worked there. For example, P. L. Kapitsa worked in Rutherford's Cavendish laboratory from 1921-1934, Yu. B. Khariton was there from 1926-1928, and K. D. Sinelnikov, A. I. Leypunski were at the Cavendish lab from 1928-1930.[11] Soviet physicists also visited Niels Bohr's laboratory in Copenhagen.

Soviet nuclear physics entered the world arena in September 1933, when the first conference on nuclear physics was held in the Soviet Union. Prominent foreign physicists participated in the conference and Soviet physicists presented the results of original research carried out in Soviet laboratories. These conferences became regular occurrences and attracted the participation of noted Soviet and foreign scientists. The second conference took place in September 1936; the third in October 1938; the fourth in November 1939. The fifth conference was scheduled for October 1941, but it was canceled because of the war.[12]

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[6] A. K. Kruglov, *"Kak sozdavalas…,"* 18.
[7] *Atomnaya Otrasl Rossii*, 37.
[8] A. M. Petros'ynts, *Problems of Nuclear Science and Technology*, 7; Kratkie Biograficheskie Dannye, *"Sozdanie…,"* 426.
[9] A. K. Kruglov, "Kak Sozdavalas…," 18.
[10] G. A. Gamov was an outstanding theoretical physicist. In 1933 he refused to return to the USSR from a trip to Europe, and in 1934 moved to the United States and since then worked there. In: A. K. Kruglov, "Kak sozdavalas…," 18.
[11] V. L. Malkov, *"Manhettenski Proekt" Razvedka I Diplomatiya* (Moskva: Nauka, 1995), 11; Kratkie Biograficheskie Dannye, *"Sozdanie…,"* 409, 427, 432.
[12] A. M. Petrosy'ants, Atomistika I Ye Shagi V Istorii, *"Sozdanie…,"* 37, 38.

There was much Soviet progress to report at these conferences. In 1934, P. A. Cherenkov and S. I. Vavilov, from FIAN, discovered one of the fundamental physical phenomena – the visible light that is emitted by when a charged particle travels through a liquid at a speed that exceeds the speed of light in that medium.[13] In 1935, I. V. Kurchatov, B. V. Kurchatov, L. V. Mysovsky, and L. I. Rusinov, from LFTI and RIAN, discovered the phenomenon of nuclear isomerism of artificial radioactive nuclei and worked out a theory of this phenomenon.[14] In 1935, I. V. Kurchatov published a monograph "Splitting of the Nucleus" in which he analyzed the results of experiments (conducted mostly abroad) on alpha-particle-induced fission of nuclei from copper to uranium. In this book Kurchatov also analyzed theoretical and experimental research on the interaction of neutrons with nuclei of different elements.[15]

In 1936, Ya. I. Frenkel proposed the liquid drop model of the nucleus and introduced thermodynamic concepts into nuclear physics. He also formulated the fundamentals of the theory of fission of heavy nuclei.[16]

From 1936 to 1941, a weekly "Nuclear seminar" was regularly held at LFTI. I.V. Kurchatov chaired the seminar; G. Ya. Shepkin, L. A. Artsimovich, G. N. Flerov, A. B. Migdal, Ya. I. Frenkel, and a number of other researchers were active participants.[17]

At the end of 1938, the Committee on the Nucleus was established under the auspices of the Presidium of the Academy of Sciences. The Committee was chaired by Academician S. I. Vavilov, Director of FIAN, and was composed of A. F. Ioffe, A. I. Alikhanov, I. V. Kurchatov, I. M. Frank, V. I. Veksler,, and A. I. Shpetni. In June 1940, the Presidium of the Academy instructed Academicians V. I. Vernadski, A. E. Fersman, and V. G. Khlopin to outline measures to speed up research in utilization of nuclear energy.[18]

In 1939, Yu. B. Khariton and Ya. B. Zeldovich described the conditions necessary for achieving a fission chain reaction in a uranium reactor and explained the use of heavy water and carbon for slowing down neutrons.[19]

In 1940, G. N. Flerov and K. A. Petrzhak discovered the spontaneous fission of uranium nuclei, i.e. they demonstrated that the uranium nucleus could disintegrate spontaneously. They calculated the energy which could be obtained by fission of 1 kg of uranium and found out that it would be equal to the energy released by burning 2,300,000 kg of the best quality coal.[20]

In 1939-40, Yu. B. Khariton and Ya. B. Zeldovich were the first in the world to publish calculations for nuclear fission chain reactions. They showed that with a slight enrichment of the natural fraction of the light uranium isotope (uranium-235), the conditions could be created for a continuous fission reaction. Their work established in

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[13] A. M. Petrosy'ants, *Problems of Nuclear Science and Technology*, 10.

[14] A. M. Petrosy'ants, *Problems of Nuclear Science and Technology*, 10; A. K. Kruglov, "Kak sozdavalas…," 19.

[15] Kurchatov I. V., *Rassheplenie Atomnogo Yadra* (Moskva-Leningtad: Redaktsiya Obshchetekhnicheskikh Distsiplin, 1935).

[16] A. M. Petrosy'ants, *Problems o Nuclear Science and Technology*, 10.

[17] A. M. Petrosy'ants, Atomistika I Ye Shagi V Istorii, "*Sozdanie…*," 33.

[18] A. M. Petrosy'ants, Atomistika I Ye Shagi V Istorii, "*Sozdanie…*," 34.

[19] Zeldovich Ya. B., Khariton Ya. B., *Zhurnal Experimentalnoi I Teoreticheskoi Fiziki*. 1939, T. 9,vyp. 12, 1425-1427; 1940, T. 10, vyp. 1, 29-36; 1940, T. 4, vyp. 5, 477-482.

[20] Petrzhak K. A., Flerov G. N., *Doklady Academii Nauk SSSR*. 1940, T. 28, vyp. 6, 500-501.

principle the possibility of achieving a nuclear chain reaction.[21] They also explored the conditions for the creation of a nuclear explosion and obtained estimates of its tremendous destructive power. They made a presentation on this subject in the Summer of 1939 at a seminar at LFTI.[22]

In the 1920s and early 1930s, Soviet physicists published the results of their theoretical and experimental research abroad, mostly in German journals. The results of their work in nuclear physics were available to Western scientists. But from the mid-thirties, they had to publish mostly in Soviet scientific journals, which were not widely translated. It would be safe to presume that since the late thirties Western physicists were mostly ignorant about Soviet physicists' achievements in nuclear research.

In 1940, the Presidium of the Academy of Sciences established the Committee on Uranium, which had responsibility to develop research on the characteristics of uranium and the possibilities of using its nuclear energy. The Committee was chaired by Academician V. G. Khlopin, Director of RIAN. Its members were Academician V. I. Vernadski (Director of RIAN up to 1939), Academician A. F. Ioffe (Director of LFTI), Academician S. I. Vavilov (Director of FIAN), Academician A. E. Fersman (RIAN), Professor A. P. Vinogradov, Professor I. V. Kurchatov (LFTI, RIAN), and ProfessorYu. B. Khariton (IKhF). This Committee coordinated the work of a number of research institutes. Its recommendations and decisions played the major role in the creation of experimental facilities at LFTI, KhFTI, and other research institutes, and in research on nuclear chain reactions. In September of 1940, the Uranium Committee approved an outline of research for 1941, which included: explanation of the mechanics of uranium and thorium fission (RIAN, LFTI, KhFTI); elucidation of conditions of sustaining chain reactions in natural mixtures of uranium isotopes (IKhF, LFTI); development of methods of fission of uranium isotopes (RIAN, KhFTI, the Biogeochemlaboratory of the Academy of Sciences, the Dnepropetrovsk Institute of Physical Chemistry); and a search for rich deployments of uranium ores (RIAN, FIAN, the Geological Institute of the Academy of Sciences).[23]

In July 1940, Academicians V. I. Vernadski, A. E. Fersman, and V. G. Khlopin sent a letter to the Deputy Chairman of the Council of People's Commissars, N. A. Bulganin. They advised that recent research in nuclear physics had led to the discovery that tremendous amounts of energy might be liberated in the process of the nuclear fission of uranium by neutron bombardment. Quoting:

> "This research puts forward a question of possible technical utilization of nuclear energy;
>
> "The importance of this is fully understood abroad. According to information, they are feverishly working on these problems, and huge outlays are assigned for it in England, the United States and Germany;
>
> "We believe that the time has now come for the Government ... to take a number of measures, which would ensure that the Soviet Union is not left behind foreign countries in this field. The following measures might be taken:

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[21] A. M. Petrosy'ants, *Problems of Nuclear Science and Technology*, 8.
[22] Zeldovich Ya. B., Khariton Yu. B., *Uspekhi Fizicheskikh Nauk.* 1983, T. 139, vyp. 3, 513.
[23] A. K. Kruglov, *"Kak Sozdavals...,"* 22; A. M. Petrosy'ants Atomistika I Ye Shagi V Istorii, *"Sozdanie...,"* 36.

"Instruct the Academy of Sciences to urgently start the development of methods for fission of uranium isotopes and construction of appropriate installations;

"Instruct the Academy of Sciences to speed up design of an ultra-powerful cyclotron for FIAN;

"Create state reserves of uranium."[24]

In 1940, at the All-Union Conference on the Physics of the Atomic Nucleus in Moscow, I. V. Kurchatov presented a report on the conditions for achieving a nuclear chain reaction.[25]

In 1940, scientists from Kharkov Physical-Technical Institute, V. Shpinel, V. Maslov, and F. Lange, submitted to the Department of Inventions of the People's Commissariat of Defense a claim for an invention entitled "On using uranium as an explosive and poisonous substance."[26] Yulii Khariton later analyzed the design of the uranium bomb that they proposed in their claim and concluded that it had nothing to do with a real atomic bomb. However, their claim demonstrates that even before the war some Soviet physicists thought about nuclear weapons. In the same year, the Director of the Institute of Chemical Physics, Academician Nikolai Semenov, sent a letter to the People's Commissariat of the Oil Industry, in which he argued that work on creation of an atomic bomb had to be accelerated. But, Semenov's letter and request from researchers from Kharkov were practically ignored.[27]

At the end of 1940, I. V. Kurchatov presented a report to the Uranium Committee in which he pointed out the economic and military significance of releasing nuclear energy from fission of uranium.[28]

The research conducted in the Leningrad Physical-Technical Institute, the Moscow Physics Institute, the Institute of Chemical Physics, the Radium Institute, and the Kharkov Physical-Technical Institute generated an extensive collection of scientific data and established the methods of theoretical and experimental nuclear physics research.

I. V. Kurchatov, in a report written in 1943, pointed out that as of June 1941, when research on uranium was terminated due to the war, Soviet physicists were studying the following specific chain reactions: in ordinary metallic uranium; in metallic uranium-235; in a mixture of ordinary uranium, enriched with uranium-235 and water; in a mixture of ordinary uranium and heavy water; and in a mixture of ordinary uranium and carbon.[29]

It is interesting to observe that the Soviet physicists who actively participated in theoretical and experimental nuclear research in the 1930s and early 1940s were very young. In 1935, Kurchatov was just 32; Khariton, 31; Zeldovich, 21; Flerov, 22;

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[24] A. M. Petrosy'ants Atomistika I Ye Shagi V Istorii, "*Sozdani...*," 35, 36.

[25] A. M. Petrosy'ants, *Problems of Nuclear Science and Technology*, 8.

[26] *Atomnaya Otrasl Rossii*, 42.

[27] Vladimir Chikov, *Nelegaly. Dosiye KGB #13676, Chast 1 Operatsiya "Enormous,"* (Moskva: Olimp, 1997), 11, 12; Yu.B. Khariton, Yu. N. Smirnov, O Nekotorykh Mifax I Legendah Vokrug Sovetskih Atomnogo I Vodorodnogo Proektov, "*Yulii Borisovich Khariton...*," 177.

[28] A. M. Petrosy'ants Atomistika I Ye Shagi V Istorii, "*Sozdanie...*," 37.

[29] Yu. B. Khariton, Yu. N. Smirnov, O Nekotorykh Mifakh I Legendakh Vokrug Sovetskih Atomnogo I Vodorodnogo Proektov, "*Yulii Borisovich Khariton...*," 178.

Petrzhak, 28; Aleksandrov, 32; Alikhanov, 31; Artsimovich, 26; and so on. These are the names we will meet later on in these pages as we turn to the Soviet atomic bomb project. It should also be mentioned that before the war scientists' salaries were miserable and appropriations for science were very low. But all these young physicists were enthusiasts. They were fascinated with their research. They worked very long hours despite low salaries, despite inadequate funds for their experiments. And their theoretical potential was very high.

However, it should be stressed that before the war nuclear physics was "pure" science. The work of Soviet physicists was held up by the absence of domestic uranium and the necessity of tremendous outlays for the creation of a large-scale specialized nuclear industry. Only a small group of enthusiasts believed that atomic problems could be solved in the near future. According to the prevailing view, the technical solution of the atomic problem could be achieved only in a distant future, not less than in 15-20 years. Before the war, despite the early attempts to inquire into the possibility of nuclear explosions, the use of nuclear power for military purposes was not on the agenda.

A. M. Petrosy'ants, who actively participated in the atomic project and later was Chairman of the State Committee for Atomic Energy Utilization, put forward a different opinion. He wrote, in an article published in 1995, that Soviet scientists were close to mastering nuclear energy, and if not for the German invasion, the Soviet army in a couple of years could have had extremely powerful nuclear weapons and that would have hindered the fulfillment of Hitler's aggressive plans. But war, and the defeats of its first period, postponed for a long time Soviet research directed at mastering nuclear energy.[30] Petrosy'ants' opinion was obviously dictated by noble and patriotic feelings, but according to all available data, it was far from reality. Only war, and the fear that German physicists would be the first to create atomic weapons, triggered the work on atomic weapons in England, the United States, and later in the Soviet Union. It is possible that without the war and the German threat, nuclear weapons would not have been created then, maybe not even in the Twentieth Century.

Nevertheless, Soviet pre-war theoretical research and experiments in nuclear physics had laid a strong foundation for future work on nuclear weapons. In the Soviet Union an outstanding school of physicists had been established whose theoretical and experimental research, including research in nuclear physics, was of a world-class level. The group of brilliant young scientists, Ya. B. Zeldovich, Yu. B. Khariton, G. N. Flerov, K. A. Petrzhak, and others informally headed by I. V. Kurchatov, was able to reach the uppermost level of world science and produce research results of outstanding pioneering quality. These achievements established Soviet scientists with a powerful starting position when, at the height of the war, they began the actual development of nuclear weapons.

[30] A. M. Petrosy'ants, Atomistika I Ye Shagi V Istorii, "*Sozdanie...*," 38.

2. HOW THE SOVIET ATOMIC BOMB PROJECT BEGAN

Soviet research in nuclear fission was terminated at the beginning of the war with Germany. Leading Moscow and Leningrad institutes engaged in nuclear research were evacuated to the Eastern parts of the country – to Kazan, Chelyabinsk, Alma-Ata, and other cities. Many scientists joined the army; others diverted their efforts from theoretical research to solving the most urgent practical problems of the war. For example, A. P. Aleksandrov at the beginning of 1941 created a system which protected ships from magnetic mines. The system was tested and put into practical use on naval vessels. When the war started, I. V. Kurchatov terminated his research in nuclear physics and joined Aleksandrov's research. They assembled a large group of scientists and sent them to teach naval officers and shipyard engineers methods of protection from magnetic mines.

Shortly after the beginning of the war, Soviet leadership started to receive information that scientists in the United States, England, and Germany were actively working on the creation of atomic weapons. Physicist Georgi Flerov noticed that publications on fission of uranium and nuclear chain reactions were no longer appearing in American, British, and German physical journals. Not a single report on new results in this field could be found after the Fall of 1941. Flerov decided that it was not a coincidence, and concluded that development of nuclear weapons was going on in these countries. Flerov began sending letters to leading physicists, to the Academy of Sciences, and to government officials arguing that not only despite the war, but especially because of the war, it was absolutely necessary to work on the development of nuclear weapons or the Soviet Union would be left behind other countries. His letters were practically ignored. In mid-1942, he sent a letter to Stalin, pleading to start work on nuclear weapons. He stressed that development of nuclear weapons would bring about a revolution in military technology and it would be a disaster if other countries were to develop it before the Soviet Union.[31] Flerov's letter to Stalin did not play a decisive role in the decision to start work on the atomic bomb, but it was added to the numerous reports from Soviet intelligence agents.

Colonel Leonid Kvasnikov, Director of the Scientific-Technical Department of the People's Commissariat of Internal Affairs, Foreign Intelligence (later KGB Foreign Intelligence), also noticed that Western scientific journals stopped publishing articles on uranium. He also concluded that research on uranium had been made secret because of its military significance. Kvasnikov sent requests to Foreign Intelligence residents in the USA, England, France, and Germany asking them "to find out the research centers where research on uranium was going on or might be going on and ensure getting information on applied research at these centers."[32]

In September 1941, Soviet Foreign Intelligence got a message from its London resident with a report of its agent code name "Homer."[33] According to his report, a meeting of the British Committee on Uranium took place on September 16, 1941. The

[31] A. M. Petrosy'ants, Reshnie Yadernoi Problemy V 1943-1946 gg, "*Sozdanie...*," 41, 42.

[32] Vladimir Chikov, *Nelegaly..*," 13, 14.

[33] Agent Homer was Donald Maclean, member of the so-called "Cambridge Five," a group of Cambridge students recruited by Soviet intelligence in the early 1930s. In the early 1940s he held a very high position in the British Foreign Office. Later he was suspected of spying, but in 1951 he was able to escape to the Soviet Union.

Chairman of the British Committee on Science, Lord Henky, chaired the meeting. At the meeting data was presented on recent uranium research and the conclusion was reached that an atomic bomb could be developed in two years. It was reported in the same message that the Committee of the Chiefs of Staffs had decided to start building a plant in England for production of uranium bombs.[34]

Then, Soviet military intelligence got information from Shandor Rado in Switzerland that nuclear research in Germany was going on very actively under the leadership of the very distinguished scientists Otto Hahn and Werner Heisenberg.

Stalin was very skeptical about the first reports on the development of nuclear weapons in England and Germany. He thought that it was impossible to create a bomb of such destructive power. He dismissed these reports as disinformation aimed at channeling scarce Soviet resources away from the war effort.

By March 1942, the People's Commissariat of Internal Affairs got a substantial amount of information on research in England directed at using nuclear energy for military purposes. On March 10, 1942, the Commissariat prepared a special letter for the State Committee on Defense (GOKO). The letter was addressed to Stalin and signed by People's Commissar Lavrenti Beria. The letter stated that in 1939 intensive research on using uranium for the development of new explosives was started in great secrecy in France, England, the USA, and Germany. Materials, obtained by intelligence in England, described the activities of the English Uranium Committee and the results of research directed at the creation of atomic weapons. The materials presented in the letter were summarized in the following conclusions:

> "The English High Military Command considers the question of using nuclear energy of uranium-235 for military purposes to be principally solved.
>
> "The Uranium Committee of the English High Command developed a preliminary theoretical plan for designing and building a plant for production of uranium bombs.
>
> "The efforts of the best scientists, research establishments, and large industrial companies in England are united and directed at development of uranium-235. These projects are especially secret."

The letter recommended measures for coordination of all work on nuclear energy in the Soviet Union.[35]

In addition, Soviet leadership was informed, mostly by intelligence, that work on the development of nuclear weapons was also going on in the United States.

In the Spring of 1942 Abram Ioffe and Sergei Kaftanov, who was Chairman of the Government's Committee on Institutions of Higher Education and the GOKO representative for science, sent a letter to the State Committee on Defense suggesting the creation of a scientific center for research in nuclear weapons.[36]

In 1942, the situation in the war with Germany was extremely dangerous. German armies continued their offensive and all efforts of the Soviet leadership were directed at the war effort. Nevertheless, on November 27, 1942, GOKO instructed the People's

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[34] Vladimir Chikov, *Nelegaly...*," 17, 18, 19.

[35] Quoted in: Petro'syants, Reshenie Yadernoi Problemy V 1943-1946 gg. "*Sozdanie...*," 42, 43, 44.

[36] Yu. B. Khariton, Yu. N. Smirnov, O Nekotoryh Mifah I Legendah Vokrug Sovetskikh Atomnogo I Vodorodnogo Proektov, "*Yulii Borisovich Khariton...*," 179.

Commissariat of Non-Ferrous Metals to start mining uranium ore. And from 1943 at the Tabasharski mine in Tadgikistan, extraction and recovery of uranium ore was started with the goal of getting 4 tons of uranium salts a year.[37]

On February 11, 1943, GOKO made a decision on the organization of efforts directed at the military use of nuclear energy. This decision established the Soviet atomic project. Supervision of the atomic project was entrusted to Vechaslav Molotov, who was the Deputy Chairman of GOKO, the First Deputy Chairman of the Council of People's Commissars, and People's Commissar of Foreign Affairs. Lavrenti Beria, member of GOKO, Deputy Chaiman of the Council of People's Commissars, and People's Commissar of Internal Affairs, was appointed his deputy, responsible for supplying the military and scientists with intelligence information. Operational support for the project and day-to-day help was entrusted to the Deputy Chairman of the Council of People's Commissars, Mikhail Pervukhin, and to Sergei Kaftanov.[38]

At this time, a special scientific center was established in Moscow: Laboratory #2 of the Academy of Sciences (at first it was entitled the Laboratory of Measuring Instruments of the Academy of Sciences, LIPAN, later the Institute of Atomic Energy named after I. V. Kurchatov, the Russian Scientific Center, "Kurchatov's Institute"). The Laboratory had to find ways to control the nuclear energy from the fission of uranium and study possibilities of its military applications. The establishment of LIPAN created the core scientific part of the Soviet atomic project.

According to a number of publications, Stalin wanted Abram F. Ioffe, one the most renowned Soviet physicists, to become scientific director of the atomic project and head of the Laboratory. Ioffe declined, referring to his advanced age (he was 63 at the time) and duties as the President of the leading physical institute. Instead, Ioffe recommended the young, 40-year-old Professor Igor V. Kurchatov. Kurchatov, by Soviet academic standards, was too young and did not have the necessary academic stature for the job. But Ioffe stressed that Kurchatov was talented, resolute, and well advanced in nuclear physics research. As a result, Kurchatov became the Scientific Director of the atomic project and the Director of LIPAN. Ioffe understood that Kurchatov had to get an academic stature appropriate for his highly responsible position. In September 1943, thanks to Ioffe's insistence, Kurchatov was elected a full member of the Soviet Academy of Sciences – the nation's highest academic distinction. At the same time, Kurchatov's friend and collaborator Abram Alikhanov was also elected full member of the Academy.

At the beginning Kurchatov's Laboratory had to take shelter in a number of rooms in two academic institutes. Then Pervukhin and Kurchatov inspected unfinished buildings of the Institute of Experimental Medicine in the Pokrovskoye-Streshnevo suburb of Moscow. These buildings and the vast surrounding territory were given to the Laboratory. It took some time to complete construction. Only in April 1944 was the Laboratory able to move into its permanent location in Pokrovskoe-Streshnevo.

During 1943 and 1944, laboratories were organized at LIPAN, preparatory research was begun, and a number of scientists were recruited. Still, the Laboratory was very small during this initial period. By the end of April 1944 only 74 employees worked in the Laboratory, among them 25 scientists, 6 engineers and technicians, 12 workers, and 31 supporting personnel. Among the scientists were I. V. Kurchatov, A. I. Alikhanov,

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[37] A. M. Petro'syans, Reshenie Yadernoi Problemy V 1943-1946 gg., "*Sozdanie...*," 45.
[38] *Atomnaya Otrasl Rossii*, 45.

Ya. B. Zeldovich, I. K. Kikoin, I. Ya. Pomeranchuk, S. L. Sobolev, G. N. Flerov, B. V. Kurchatov, V. A. Davidenko, and others.[39]

Kurchatov thought that the Laboratory's main task was conducting research into developing a nuclear reactor using slow neutrons to produce a chain reaction in plutonium-239 and uranium-235. Kurchatov planned to use natural uranium in the reactor. In the period when LIPAN was getting organized, Kurchatov was personally engaged in physical, chemical, and engineering research. Yu. B. Khariton and Yu. N. Smirnov stressed the "outstanding importance of I. V. Kurchatov as a supervisor of all research on nuclear problems, and in forming from the very beginning a strategically correct program of research." From its first days and first steps, wrote Khariton and Smirnov, the Soviet atomic project, which had as its starting foundation the wonderful accomplishments of Soviet physicists, got, thanks to Kurchatov, an absolutely correct program for its fulfillment. They noted, however, that up to 1945 this program was carried out with very limited personnel and using "insignificant" resources.[40]

The situation drastically changed after the Japanese cities of Hiroshima and Nagasaki were destroyed by American atomic bombs. It became obvious that the United States had a new weapon of a tremendous destructive power. For Stalin it was news of outstanding strategic importance. He knew about the atomic bomb project in the United States, of course. Soviet intelligence informed him about the first test of an American atomic device on July 16, 1945 at Alamogordo, New Mexico. But the practical military use of atomic bombs made a tremendous impression on him. Atomic blasts were the final blows which put Japan on her knees. At the same time, atomic weapons had drastically changed the balance of military power to the advantage of the United States. Stalin thought that American leaders would use atomic weapons to threaten the Soviet Union and to dictate their will in world politics. Stalin wanted to have a Soviet atomic bomb in the shortest time possible. He understood that development and production of atomic weapons--a complex job of extreme difficulty--required extraordinary measures: the mobilization of all human and material recourses. The Atomic project had to become national priority #1. To accomplish this, a new state agency with very broad powers had to be established.

On August 20, 1945, the State Committee on Defense established the Special Committee of GOKO by a decree #9887 ss/op (ss/op – sovershenno sekretno/osobaya papka – top secret/special file -- the highest security classification in the Soviet Union), signed by Stalin.[41] The Special Committee included: L. P. Beria (chairman), G. M. Malenkov, N. A. Voznesenski, B. L. Vannikov, A. P. Zaveniygin, I. V. Kurchatov, P. L. Kapitsa, V. A. Makhnev, and M. G. Pervukhin,

The Special Committee was charged "with management of all activities for *the utilization of nuclear energy from uranium:*

promotion of research in this field;

broad unrolling of *geological prospecting* and creation of Soviet raw material base of mining *uranium*, and also using *uranium* deposits

[39] A. M. Petrosy'ants, Reshenie Yadernoi Problemy V 1943-1946 gg., "*Sozdanie...,*" 46,47.

[40] Yu. B. Khariton, Yu. N. Smirnov, O Nekotoryh Mifah I Legendah Vokrug Sovetskikh Atomnogo I Vodorodnogo Proektov, "*Yulii Borisovich Khariton...,*" 180, 182.

[41] Full text of GOKO decree from original document in: Ministerstvo Rossiiskoi Federatsii po Atomnoi Energii. *Atomnii Proekt SSSR. Documenty I Materialy. Tom 2, Atomnaya Bomba, 1945-1954*, Kniga 1 (Sarov: RFNC-VNIIEF, 1999), 11-14.

outside of the Soviet borders (in *Bulgaria, Czechoslovakia* and *other countries*);

creation of the industry for purification of *uranium*,

production of special equipment and materials, connected with *utilization of nuclear energy*;

and also building of *nuclear-energy facilities and development and production of an atomic bomb*

(in the original Russian text of the document, the words in italics were inserted in longhand. Soviet leaders obviously did not trust their typists).

The Special Committee was entrusted with vast powers. It had the right to carry out all executive measures necessary for the fulfillment of tasks commissioned to it, to issue orders to the People's Commissariats and separate Departments, which were obligatory for fulfillment. At its meetings, all principal organizational problems which emerged in the course of the project were to be considered. At the meetings, draft decisions and orders of the GOKO and the Council of People's Commissars (the Council of Ministers) related to the atomic project were discussed, corrected, and approved, for later presentation to Stalin for affirmation.

With the end of the war, the State Committee on Defense was abolished, and from September 1945 the Special Committee became "The Special Committee of the Council of People's Commissars."[42]

In March 1946, the Council of People's Commissars was reorganized into the Council of Ministers and the Special Committee became "The Special Committee of the Council of Ministers."[43]

Lavrentii Beria was made Chairman of the Special Committee; he replaced Molotov as the top manager of the atomic project. Molotov was relieved of his duties in the atomic project for good reason. Molotov's "style of leadership and accordingly results were not marked with effectiveness. I. V. Kurchtov made no secret of his dissatisfaction," wrote Yu. B. Khariton and Yu. N. Smirnov.[44]

Beria was one of the most terrible characters in Stalin's last inner circle. From 1938, Beria was Narodnii Komissar Vnutrennikh Del (People's Commissar, later Minister of Internal Affairs; the Russian abbreviation for this Commissariat was NKVD). He was Stalin's top hangman. Under Beria's leadership, the Commissariat of Internal Affairs carried out mass arrests, executions, and deportations of ethnic groups--Kalmyks, Ingush, Chechens, and others--were sent to the remote steppes of Kazakhstan and Siberia. Beria personally participated in interrogations and beatings of the prisoners. But, at the same time, this terrible man was a very bright and effective manager -- he possessed a strong will, great energy, and efficiency. During the war as a GOKO member he had vast experience in running the defense industry, especially the production of artillery. As the People's Commissar of Internal Affairs, he got all intelligence information on the development of nuclear projects in the United States and Great Britain, and he regularly informed Stalin about it. In addition, the People's Commissariat of Internal Affairs had at its disposal an unlimited supply of free labor from the prison camps.

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[42] *Atomnii Proekt SSSR*, 20.

[43] *Atomnii Proekt SSSR*, 82.

[44] Yu. B Khariton, Yu. N. Smirnov, O Nekotorykh Mifah I Legendakh Vokrug Sovetskikh Atomnogo I Vodorodnogo Proektov, "*Yulii Borisovich Khariton…*," 183.

A special paragraph of the GOKO decree stated: "To instruct Comrade Beria to take measures for organizing *intelligence work outside of the country* directed at getting more complete technical and economic information about the *uranium industry and atomic bombs*, entrusting him with management of all *intelligence work in this field*, carried out by *intelligence agencies (the People's Commissariat of Internal Affairs, the Intelligence Department of the Red Army, and others*). (The words in italics were inserted in longhand.)

Beria was in charge of the Soviet atomic project up to 1953, a period of nearly 8 years.

The other top Communist Party and Government officials included in the Special Committee also had the stature necessary for the jobs entrusted to them.

Georgi Malenkov was a GOKO member and the very powerful Secretary of the Central Committee of the Communist party. As Stalin's deputy, he ran the Communist party apparatus from the Central Committee down. Like Beria, he had extensive war-time experience in running the defense industry -- as a GOKO member he was responsible for the production of combat airplanes. Malenkov had to ensure that the Communist party apparatus would do everything possible and impossible to help the development of atomic bomb.

Nikolai Voznesenski was also a GOKO member, Deputy Chairman of the Government and Chairman of the State Planning Committee. He had to ensure that the demands of the nuclear project would have the top priority in economic plans.

Boris Vannikov was one of the best and most experienced managers of the defense industries. Before the war he was the People's Commissar of Armaments, and during the war, the People's Commissar of Munitions.

Avraamii Zavenyagin was the Deputy People's Commissar of Internal Affairs, and from 1943 was involved in the atomic project.

Academician Peter Kapitsa was a world-renowned physicist. From 1935, after his return from working with Rutherford at Cambridge, he was Director of the Institute of Physical Problems. Later he won the Nobel prize in physics.

Academician Igor Kurchatov from the very start was the Scientific Director of the atomic project.

NKVD General V. Makhnev was appointed secretary of the Special Committee.

Mikhail Pervukhin was Deputy Chairman of the Council of People's Commissars and from the beginning supervised the nuclear project under Molotov.

The same GOKO decision established the Technological Council under the Special Committee. The Technological Council gave preliminary consideration to scientific and technological issues which were to be presented to the Special Committee for action, namely research plans, technical projects, and development of new buildings and installations. Vannikov was appointed Chairman of the Technological Council. Among its members were Zavenyiagin and noted scientists Ioffe, Alikhanov, Kapitsa, Kikoin, Kurchatov, Khariton, and Khlopin.

At the end of August 1945, the Special Committee established the Engineering-Technological Council, chaired by Mikhail Pervukhin.

At its meeting on September 28, 1945, the Special Committee made a decision to establish Bureau #2 within the Committee, reporting directly to the Chairman. Bureau #2 was charged with translating and processing of documents and materials coming to the

Committee from different sources, and with studying the activities of foreign research establishments, plants, and companies engaged in nuclear projects. The true nature of the work at Bureau #2 could be ascertained from the personnel appointed. Notorious spy-master NKVD General Pavel Sudoplatov was appointed Bureau Chief; among his deputies were NKVD General Naum Eytingon (he organized the murder of Lev Trotsky in Mexico) and NKVD Colonel Lev Vasilevski.[45]

The GOKO decision establishing the Special Committee also established the First Chief Directorate (Pervoe Glavnoye Upravlenie or PGU) of the Council of People's Commissars, subordinate to the Special Committee. The PGU was established "for direct management of research and design organizations, industrial plants *engaged in the utilization of nuclear energy from uranium and production of atomic bombs*" (the words in italics were inserted in longhand).

The First Chief Directorate was also endowed with extraordinary powers and privileges. All projects conducted by enterprises and research institutions of the First Chief Directorate, or for it by enterprises of different ministries or departments, were to be controlled by the Special Committee. "Departments, institutions, or persons," stated the GOKO decision, "have no right to interfere into the activities of the First Chief Directorate, its enterprises and establishments without special permission of GOKO, or demand information about its activities or works conducted on First Chief Directorate orders."

Boris Vannikov was appointed Director of the First Chief Directorate and Deputy Chairman of the Special Committee. Due to these new appointments he was relieved of his duties as People's Commissar of Munitions. It is interesting to mention that in addition to this extremely important, top secret appointment, Boris Vannikov got another appointment. In March 1946, the Council of People's Commissars was transformed into the Council of Ministers and Vannikov was appointed the Minister of Machine-Building for Agriculture.[46] This Ministry inherited from the People's Commissariat of Munitions (the Commissariat of Munitions was disbanded) plants and research facilities which could be used in the nuclear project. Vannikov, as was already mentioned, was the People's Commissar of Munitions during the war.

Avraamii Zavenyagin was appointed the First Deputy Director of the First Chief Directorate. In the late 1930s, he was the First Deputy to the People's Commissar of Heavy Industry, and he was in charge of construction of the Norilsk mining and metallurgical industrial complex, which was built by the People's Commissariat of Internal Affairs. From 1941, he was the Deputy People's Commissar of Internal Affairs, and from 1943 he was involved in the atomic project.[47]

The Deputies to the Director of the First Chief Directorate were:

Nikolai Borisov – Deputy Chairman of the State Planning Committee. In this Committee under Borisov, Administration #1 was established to carry out planning and financing of all the projects, nation-wide, directed at the development of nuclear science and industry.[48]

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[45] *Atomni Proekt SSSR*, 29, 30.

[46] Ob Obrazovanii Pravitelstva SSSR – Soveta Ministrov SSSR, *Pravda*, 21 March,1946.

[47] Kratkie Biograficheskie Dannye, "*Sozdanie...*," 404.

[48] Kratkie Biograficheskie Dannye, "*Sozdanie...*," 392.

Pavel Meshik – NKVD Lieutenant-General. From 1943-1945, he was Deputy Director of the Chief Directorate of Counterintelligence of the People's Commissariat of Internal Affairs. In the First Chief Directorate he was responsible for arranging security and maintaining the regime of strict secrecy at the industrial enterprises, research and design organizations which were engaged in the development of nuclear weapons.[49]

Peter Antropov – Minister of Geology from 1953-1962. In the First Chief Directorate he was responsible for development of the uranium mining enterprises in the Soviet Union and Eastern Europe.[50]

Andrei Kasatkin – Deputy People's Commissar of Chemical Industries. In the First Chief Directorate he made a great contribution in the development of different chemical materials for the nuclear industry.[51]

Later, Vasilii Yemelyanov, Deputy People's Commissar of Metallurgy; Ephim Slavski, Deputy People's Commissar of Non-Ferrous Metals Industry; and Aleksandr Komarovski, Director of the Main Administration of Construction of the People's Commissariat of Internal Affairs, were added to the First Chief Directorate. Komarovski was in charge of construction of the major facilities of the nuclear industry.

The First Chief Directorate became a super-ministry with extraordinary powers, privileges, and stature in the Soviet Government's structure. The research and design organizations, construction enterprises, and industrial plants which were needed for its work were all transferred to the First Chief Directorate. The best scientists, the best industrial managers, the best engineers, tens of thousands of workers, numerous plants, research and design facilities, and thousands and thousands of inmates from prison camps were engaged in the atomic project.

On October 5, 1945, the Council of People's Commissars approved the structure of the PGU and appointed the directors of the main departments and sections.[52]

The establishment of the Special Committee and the First Chief Directorate created a very powerful structure for managing the development and production of the atomic bomb. The Atomic project had become the top national priority. The country's leadership was directly involved in the development and production of the atomic bomb. The project was under the direct day-to-day control of Stalin. The Special Committee regularly reported to Stalin about its activities and progress of all the important endeavors.

Members of the Special Committee, thanks to their status, were able to force any Soviet official to do the job necessary for the nuclear project. No excuses were taken into consideration. All had to be done in the shortest time possible. The method of the Special Committee's work, with its direct responsibility to Stalin, commanded respect and, at the same time, put fear in everybody--fear not to be able to do the assigned job or not to do it well enough. At its meetings, the Special Committee regularly received reports from Ministers and top officials of the different ministries on how their industries and enterprises were fulfilling the PGU demands and orders. All ministers, the directors of all departments and organizations which participated in the project did all possible, and at times the impossible, not to risk punishment for failing to do the necessary job.

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[49] Kratkie Biograficheskie Dannye, "*Sozdanie...,*" 415.
[50] Kratkie Biograficheskie Dannye, "*Sozdanie...,*" 391.
[51] Kratkie Biograficheskie Dannye, "*Sozdanie...,*" 410.
[52] *Atomnaya Otrasl Rossii*, 52.

Lavrentii Beria performed an outstanding role. Participants in the atomic project in their recent publications have had to admit the role this terrible man performed in the project. Yulii Khariton, the noted physicist who was the Chief Designer of nuclear weapons, wrote with Yu.N. Smirnov: "Beria quickly heartened all work on the project with necessary scope and dynamism. This man, who impersonated evil in the country's modern history, possessed at the same time tremendous vigor and efficiency. . . . It was impossible not to admit his intellect, willpower, and purposefulness. He was a first-class manager, who was able to bring every job to its conclusion"[53] Beria often visited different building sites, research and industrial facilities, got acquainted with the progress and results of the project, supplied necessary assistance, and at the same time severely punished negligent officials, managers, or any other participants in the project without paying attention to their rank or stature. He was able to use all the necessary scientific potential and industrial capacity of the country for creating the nuclear industry and producing the atomic bomb. At the same time, as People's Commissar, later Minister of Internal Affairs, he was in command of innumerable masses of prison camp inmates, who were used for construction of enterprises and research facilities of the atomic industry and for the atomic project's most difficult and dangerous jobs. And it should not be forgotten that Beria inspired fear. All participants of the nuclear project knew that they could be easily moved from their laboratories, plants, or building sites to prison camps. Fear was not a small component of his management technique.

It should be noted that Academician Peter Kapitsa in a letter to Stalin of November 25, 1945, which was only recently published in full, put forward a critical appraisal of Beria's management, of his and other high officials' attitudes toward science and scientists. In this letter, Kapitsa admitted that Beria was "very energetic, perfectly and rapidly orients himself, is good at distinguishing the secondary from the most important. Because of that he did not waste time. He is genuinely interested in scientific matters, he precisely formulates his decisions." Admitting these positive characteristics, Kapitsa turned to Beria's shortcomings. First, in Kapitsa's view, was "excessive self-assurance." "Comrades Beria, Malenkov, Voznesenski behave themselves at the meeting of the Special Committee as super-humans. Especially, Comrade Beria. Of course, the conductor's baton is in his hands. . . . But the conductor has to understand the score, not only wave his baton." Kapitsa wrote that Beria and other high officials were ignorant in physics, but thought that they knew and understood everything. He mentioned that he offered to teach physics to Beria, which did not happen. In his letter, Kapitsa stressed that Beria and other high officials took the wrong attitude towards scientists, treating them as subsidiary personnel. For the success of atomic project, stressed Kapitsa, scientists should be leading, and not a subsidiary force in the project. He suggested that leading scientists should become a kind of "Scientific Commissars," attached to high officials. These "Commissars" had to ensure that officials would make scientifically correct decisions. Kapitsa wrote that with the present organization of the activities of the Special Committee and the Technological Council, and his strained relations with Beria, his presence there was useless, and asked to be relived of his duties.[54]

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[53] Yu. B. Khariton, Yu. N. Smirnov, O Nekotorih Mifah I Legendah Vokrug Sovetskih Atomnogo I Vodorodnogo Proektov, *"Yulii Borisivich Khariton...,"* 183.
[54] *Atomnii Proekt SSSR*, 613-620.

Kapitsa's letter obviously did not have any real influence. Beria continued to be in charge of the project. His knowledge of physics remained as it was. His attitude towards scientists did not change. In the course of the future work high officials demonstrated many times that they did not completely trust Soviet physicists' advice, conclusions, and proposals.

In December 1945, Kapitsa was relived of his membership in the Special Committee and the Technological Council. In August 1946, Kapitsa was fired from his position as Director of the Institute of Physical Problems of the Academy of Sciences.[55] However, his confrontation with Beria did not end up in arrest and prison camp. Very few were so lucky.

The First Chief Directorate needed facilities as well as people. At the beginning, Laboratory #2 was transferred under the command of the First Chief Directorate. Others followed. Plant #12 (city Electrostal, near Moscow), the State Design Institute #11 (Leningrad), and Machine-Building Plant #48 (Moscow) were transferred from the People's Commissariat of Munitions. From the People's Commissariat of Internal Affairs came Combine #6 (Tadjikistan, engaged in mining of uranium), Directorate #9, and Research Institute #9.[56]

On 1 December 1945, Laboratory #3 of the Academy of Sciences was established for the development of heavy water reactors using natural uranium. Its first director was Academician A. Alikhanov.[57]

In December 1945, two special design bureaus were established at Kirov's plant in Leningrad for developing equipment to produce enriched uranium-235 using gas diffusion and electromagnetic methods.

On April 9, 1946, the Council of Ministers approved a new (second) structure of the First Chief Directorate. It included: Directorate #1(mining and metallurgy), Directorate #2 (special enterprises), Directorate #3 (scientific institutions), Directorate #4 (construction), Directorate #5 (equipment and instruments), Directorate #6 (material-technical supplies), Directorate #7 (economic planning), and sections for personnel, financing, safety measures, transportation, etc. B. L Vannikov was affirmed as PGU Director; A. P. Zavenyagin, his First Deputy. The Deputies were: P. Ya. Antropov (Director of Directorate #1), E. P. Slavski (Director of Directorate #2), V. S. Yemelyanov (Director of Directorate #3), A. N. Komarovski (Director of Directorate #4), N. A. Borisov (Director of Directorate #5); P. Ya. Meshik, and V. G. Kostygov.[58]

In April 1946, the Technological Council and the Engineering-Technological Council were re-organized into the Scientific-Engineering Council (NTS) of the First Chief Directorate.[59] The NTS included: B. L. Vannikov, chairman; M. G. Pervukhin and I.V. Kurchatov, deputy chairmen; V. A. Malyshev, A. P. Zavenyagin, A. F. Ioffe, V. G. Khlopin, A. I. Alikhanov, N. N. Semenov, D. V. Skobeltsyn, Yu. B. Khariton, A. I. Leypunski, B. S. Posdnyakov, members of the Council.[60] As can be seen, the NTS

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[55] *Atomnii Proekt SSSR*, 619, 629.
[56] A. Kruglov, "*Kak Sozdavalas*...," 37, 38.
[57] *Atomnaya Otrasl Rossii*, 53.
[58] *Atomnaya Otrasl Rossii*, 56.
[59] A. Kruglov, "*Kak Sozdavalas*..." 40,41.
[60] A. K. Kruglov, A. M. Petros'uyants, Pervye NII, KB I Proektnye Organisatsii, Rabotavshie Dlya Sozdaniya Yadernoi Industrii, "*Sozdanie*...," 384.

included two Deputy Prime-Ministers, the Director and First Deputy Director of the PGU and noted scientists. The NTS had five sections:

1. Nuclear reactors, chief M. Pervukhin;
2. Diffusion method of uranium enrichment, chief V. Malyshev;[61]
3. Electromagnetic fission of uranium isotopes, chiefs I. Kabanov and D. Efremov;
4. Metallurgy and Chemistry, chief V. Yemelyanov;
5. Medical-Sanitary Control, chiefs V. Parin and G. Frank.

I. Kurchatov and V. Khlopin were appointed scientific supervisors of the appropriate divisions of nuclear science. M. Pervukhin was appointed first deputy chairman of the PGU and from 1947-1949 was acting chairman of the NTS. I. Kurchatov was deputy chairman, and from 1949 chairman of the NTS.[62]

Both the Special Committee and First Chief Directorate functioned for nearly 8 years. Their activities spanned the most important period of implementation of the Soviet atomic project – the creation of the atomic industry in the Soviet Union, the development, production and testing of the first Soviet atomic bomb RDS-1 and improved atomic bombs RDS-2, RDS-3, RDS-4, RDS-5, and also the development and design of the first Soviet hydrogen bomb RDS-6c. The Special Committee was abolished on June 26, 1953, by the decision of the Presidium of the Central Committee of the Communist Party immediately after the arrest of Beria.[63] At the same time, the First Chief Directorate was reorganized into the Ministry of Medium Machine Building, which became the manager of the Soviet atomic industry.[64]

[61] Pervukhin and Malyshev were Deputies to the Chairman of the Council of Ministers and Ministers of Chemical Industry and Machine-Building for Transportation Industry, respectively.

[62] A. K. Kruglov, *"Kak Sozdavalas…,"* 41.

[63] After the trial, Beria and a number of his subordinates were sentenced to death for their crimes and executed. Among them was General Pavel Meshik, former deputy director of PGU. At the time of arrest he was Minister of Internal Affairs of the Ukranian Republic. After Beria's arrest, many KGB officials were arrested, among them Generals P. Suduplatov and N. Eytingon, who spent years in prison.

[64] *Atomni Proekt SSSR*, 4.

3. CREATION OF THE SOVIET URANIUM INDUSTRY

The Special Committee and the First Chief Directorate were in charge of all activities directed at the development of the Soviet atomic bomb. It was a tremendous undertaking!

Special fuels were needed for the atomic bomb, materials which could produce a nuclear explosion. The bomb itself was a very complex construction, which had to be designed and manufactured. Development and production of fuels and construction of the bomb had to be started from scratch, and both major tasks had to be addressed at the same time.

The fuels for the bomb were plutonium-239 and uranium-235. They could be produced from pure uranium, but the Soviet Union did not have a uranium industry because uranium had not been needed before. So, uranium ores had to be prospected and uranium had to be extracted, purified, and manufactured into industrial products with specified qualities. However, the industrial technology for the production of plutonium-239 and uranium-235 did not exist in the Soviet Union. Therefore, a tremendous amount of theoretical and experimental research was needed. Then the uranium industry had to be created -- the most modern special branch of industry, with extremely complex technology, equipment and products. It needed skilled personnel to design and produce the new equipment, develop the technology for it, and make it work.

The research to develop the methods to produce plutonium-239 and uranium-235 for military purposes was undertaken at Laboratory #2. First of all, Kurchatov needed a research reactor, which could produce experimental quantities of plutonium-239 and uranium-235. Therefore, from the very beginning, all effort at Laboratory #2 was directed by Kurchatov toward building a research uranium-graphite reactor. As early as 1943, Kurchatov decided that the main task was producing plutonium-239. Kurchatov then called plutonium "eka-osmii." In a top secret note to Mikhail Pervukhin on March 22, 1943 (written in a long hand, in one copy), Kurchatov wrote: "If in reality eka-osmii has the same characteristics, as uranium-235, it would be possible to isolate it in a 'uranium boiler' and use it as a material for an 'eka-osmii' bomb." The first Soviet atomic device, detonated in 1949, was filled with plutonium.[65]

Along with construction of the first reactor, F-1 (it was then called a "nuclear boiler"; the term "reactor" did not come into usage in the Soviet Union until long after the war), Kurchatov personally controlled the construction of the first Moscow cyclotron. He had obtained the details of the cyclotron from LFTI. All details of the cyclotron, which during the blockade of Leningrad were kept in LFTI basements, were brought to Moscow. On September 25, 1944, the cyclotron became operational at Laboratory #2. It was the first cyclotron in Moscow and the only one working in the Soviet Union at the time. This cyclotron was used to produce the first micrograms of plutonium necessary for nuclear research.

The operation of the reactor required large quantities of uranium. Kurchatov's research reactor F-1 would need about 50 tons of pure natural uranium mostly in the form of metallic blocks. But, the Soviet Union simply did not have the needed quantities of uranium because the mining of uranium ore was still at an initial stage.

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[65] A. M. Petrosy'ants, Reshenie Yadernoi Problemy V 1943-1946 gg., "*Sozdanie...,*" 58.

The development of supplies of raw materials for the nuclear project began after GOKO decided on November 27, 1942 to create a uranium industry in the Soviet Union. Beginning in 1943, prospecting for uranium was started in Soviet Central Asia, but only very limited prospecting was done in 1943-1944. The extraction of uranium started in the most difficult conditions. All the mines were at a very low technical level and were far from adequately staffed. On April 2, 1945, there were only 565 workers, including construction workers. There were no roads and no living quarters. In 1944-1945, uranium ore extracted from the mines in the Pamir Mountains was transported along mountain paths on donkeys and, from time to time, on camels. Those small plants that did exist did not have modern machinery and technology for processing uranium.[66]

On December 8, 1944, GOKO decided to transfer the mining and processing of uranium from the People's Commissariat of Non-Ferrous Metals to the People's Commissariat of Internal Affairs (NKVD). In the Main Directorate of Mining and Metallurgical Enterprises of this Commissariat, Directorate #9 was established for managing prospecting, mining, and processing of uranium. Within Directorate #9, Research Institute #9 was established to research uranium deposits and develop the technology for processing uranium ore into metallic uranium. Directorate #9 reported to the Deputy People's Commissar of Internal Affairs, A.P. Zaveniyagin. Stalin made Zaveniyagin responsible for prospecting uranium ores and ordered him to start extracting them immediately. The same GOKO decision directed construction of a large uranium mining enterprise in Soviet Central Asia, based on the uranium deposits in Tadjikistan, Uzbekistan, and Kirghyzstan.[67]

On May 15, 1945, GOKO established the Mining-Chemical Combine #6 to extract and process uranium from uranium deposits in Soviet Central Asia. It was the first domestic Combine established for extracting nuclear raw materials. With the creation of this new branch of the nuclear industry, the flow of raw materials began. NKVD Colonel B.N. Chirkov was appointed as the Combine's first director.[68] Later, after the First Chief Directorate was established to manage the nuclear program, the First Directorate was formed within its structure for the management of uranium extraction and processing. P. Ya. Antropov was appointed its director. In October 1945, Directorate #9, with Research Institute #9 and Combine #6, was transferred from the People's Commissariat of Internal Affairs to the First Chief Directorate.[69]

However, extraction and processing of uranium was only the first stage of preparing uranium for nuclear reactors. Reactors needed very pure metallic uranium. In November 1944, Kurchatov first established the technical requirements for the manufacture of metallic uranium for the research reactor F-1. The manufacturing technology was developed, according Kurchatov's requirements, at the Giredmet (State Institute of Rare Metals) of the People's Commissariat of Non-Ferrous Metals. The first ingot of pure metallic uranium of more then 1 kg was delivered in December 1944. But Kurchatov needed 50 tons of pure metallic uranium for his research reactor at Laboratory

[66] V. I. Vetrov, V. V. Krotkov, V. V. Kunichenko, Sozdanie Predpriyatii Po Dodbyche I Pererabotke Uranovykh Rud, "*Sozdanie...,*" 172, 182, 183.
[67] *Atomnaya Otrasl Rossii*, 46, 47; A. M. Petrosy'ants, Reshenie Yadernoi Problemy V 1943-1946 gg, "*Sozdanie...,*" 48.
[68] V. I. Vetrov, V. V. Krotkov, V. V. Kunichenko, Sozdanie Predpriyatii Po Dobyche I Pererabotke Uranovykh Rud, "*Sozdanie...,*" 179.
[69] *Atomnaya Otrasl Rossii*, 52.

#2! The job of producing the required quantities of uranium had been entrusted to Plant #12 (in Electrostal, near Moscow), but it was impossible to get the needed quantities of pure metallic uranium from domestic uranium. It simply did not exist at the time. The problem was solved with German uranium.[70]

After Germany was defeated, the Soviet Union as well as her Western allies sent teams of specialists in various scientific and technical fields into German territory. The nuclear specialists had to find out what the German nuclear project had accomplished, identify which German scientists had worked on nuclear weapons, and recover stocks of uranium in their respective zones of occupation. The Soviets uncovered the equipment of the Physics Institute of the Kaiser Wilhelm Society in Berlin on May 5, 1945. A group of Soviet specialists, headed by A. P. Zaveniyagin, which included Yu. B. Khariton, I. K. Kikoin, V. A. Makhnev and others, was sent to Germany to inspect these findings, and on May 10 GOKO decided to move the property of Physics Institute to Laboratory #2 in Moscow.

One of the most important achievements of Zaveniyagin's group was the discovery of some 100 tons of uranium compounds. Part of this uranium had been found and brought back to Germany by the Germans when they occupied Belgium. But since the German nuclear project was at an initial stage, the uranium was not used. At the end of 1945, the uranium found in Germany was taken to the Soviet Union, where it was used at Plant #12 to produce uranium blocks for the F-1 research reactor.[71]

In recent publications, Soviet specialists proudly claim that the problem of producing metallic uranium was solved in 6 months in the Soviet Union (June-November 1946), whereas in the United States it required 23 months (1941 and 11 months of 1942). It is worth mentioning that Enrico Fermi's research reactor SR-1 in Chicago needed only 6 tons of uranium blocks, while Kurchatov's reactor F-1 needed 6-8 times as much uranium blocks.[72]

The next problem was obtaining graphite blocks to be used as the moderator in the nuclear reactors. Nuclear reactors require very pure graphite. The development and delivery of pure graphite for nuclear reactors was entrusted to the Moscow Electrode Plant. In order to produce graphite of the required quality, the plant had to change technology and replace all its equipment. By August 1945, a special technological process was developed and production of the graphite for research reactor F-1 was started.[73]

The creation of the uranium industry was impossible without a tremendous amount of research. The Special Committee, First Chief Directorate, addressed this issue from the very beginning. At its meeting on September 28, 1945 the Special Committee approved the following decision of the Technological Council of the Special Committee.[74] For the most intensive development of scientific and practical problems connected with using of nuclei energy, the Technological Council considered it necessary to involve 20 additional institutions in the project. Among them were:

[70] A. M. Petrosy'ants, Reshenie Yadernoi Problemy V 1943-1946 gg., "*Sozdanie...,*" 48, 49.
[71] *Atomnaya Otrasl Rossii*, 48; A. M. Petrosy'ants, Reshenie Yadernoi Problemy V 1943-1946 gg., "*Sozdanie...,*" 64.
[72] A. M. Petrosy'ants, Reshenie Yadernoi Problemy V 1943-1946 gg., "*Sozdanie...,*" 49.
[73] A. M. Petrosy'ants, Reshenie Yadernoi Problemy V 1943-1946 gg., "*Sozdanie...,*" 49, 58.
[74] *Atomnii Proekt SSSR*. 28.

- The Physical-Technical Institute of the Academy of Sciences (LFTI) – Director Academician A. F. Ioffe;

- The Physics Institute of the Academy of Sciences (FIAN) – Director Academician S. I. Vavilov;

- The Radium Institute of the Academy (RIAN) – Director Academician V. G. Khlopin;

- The Colloidal-Electrochemical Institute of the Academy – Director Academician A. N. Frumkin;

- The Institute of Inorganic Chemistry – Director Academician I. I. Chernyev;

- The Institute of Chemical Physics (IKhF) – Director Academician N.N. Semenov;

- The Physical-Technical Institute of the Ukrainian Academy of Sciences – Director Professor K. D. Sinelnikov;

- The Physical-Chemical Institute of the People's Commissariat of the Chemical Industry – Deputy Director Professor N. M. Zhavoronkov.

For every institution the Technical Council determined specific jobs to be undertaken. A few examples:

- LFTI had to obtain measurable quantities of plutonium through irradiation of uranium. For that, the construction of their cyclotron had to be completed as quickly as possible. LFTI also had to research new methods of splitting uranium isotopes, including carrying out calculations on inducing fission through ion bombardment.

- FIAN had to carry out calculations for uranium-graphite and uranium-heavy water reactors and determine neutron absorption in graphite and heavy water.

- RIAN had to research chemical characteristics of plutonium and develop industrial methods for isolating plutonium and radioactive substances from reactors.

- The Institute of Inorganic Chemistry was given the same task as RIAN--to research chemical characteristics of plutonium and develop an industrial method of isolating plutonium and radioactive substances from reactors.[75]

Laboratory #3 of the Academy of Sciences was established in December 1945, on the initiative of the Technological Council of the Special Committee; its purpose was to develop heavy-water reactors for producing plutonium. The Laboratory was given a territory of 100 hectares in a Moscow suburb, and Academician A. Alikhanov was appointed its director. The work on heavy-water reactors was of primary importance because these reactors needed 10-15 times less uranium fuel than other types of reactors. The Laboratory was charged with research, design and construction of heavy-water uranium reactors; research on thorium-water and thorium-plutonium-water systems for producing uranium-235; research on beta-radioactivity; and research on high-energy nuclear particles and cosmic rays. From the beginning the general directions of the Laboratory's research on heavy-water reactors were the theory of nuclear reactors, determining experimental values of the physical constants necessary for reactor calculations, optimization of reactor physical characteristics, physics and thermal engineering, burning up of nuclear fuel and accumulation of plutonium, and problems of reactor stability. The theory of reactors was developed under the leadership of the noted theoretical physicist I. Ya. Pomeranchuk. Other noted theoreticians from different Institutes of the Academy also participated in this effort, including L. D. Landau, I. E.

[75] *Atomnii Proekt SSSR*, 30-34.

Tamm, A. B. Migdal, and I. I. Gurevich. Their research established the theoretical foundations for developing the first experimental and industrial heavy-water reactors using natural uranium fuel.[76] In April 1949, the Laboratory completed their first experimental reactor, and based on this designed the first industrial heavy-water reactor, which was later built in the southern Urals.[77]

In addition, a decision was made to engage German specialists in Soviet uranium research. In Germany, Soviet specialists had obtained sufficient information to make up an organizational chart for the German nuclear weapons project, to establish the scope of that project, and to assess the results achieved before capitulation. The decision was made to enlist the services of prominent German scientists, mostly for uranium research. Soviet authorities offered a number of German scientists the opportunity to work in the Soviet Union under contract. The proposal was accepted by Nobel Prize-winner Professor H. Hertz, Professor Baron von Ardenne, Professors R. Doppel, P. Thiessen, M. Volmer, G. Pose; Doctor N. Reihl, and others. All in all, about 200 specialists came from Germany, among them 33 doctors of science, 77 engineers, and 80 laboratory assistants. By the end of 1948 approximately 300 German specialists and skilled workers were in the Soviet Union.[78]

At its meeting of September 8, 1945, the Special Committee authorized German specialists to work on the nuclear project and determined the principal tasks for the different groups:

- For the group headed by Professor Ardenne:
  - Develop the magnetic method of uranium isotope separation and mass spectrometry of heavy atoms;
  - Work on refinement of electronic microscopes and participation in their serial production;
  - Development of auxiliary equipment for nuclear research.
- For the group headed by Professor Hertz:
  - Develop methods of uranium isotope separation;
  - Develop methods of producing heavy water;
  - Develop methods of uranium isotope analysis;
  - Develop precise methodology of measuring the energy of neutrons.

For the group headed by Doctor Reihl:
  - Develop methods of producing pure uranium products and metallic uranium;
  - Scientific-technological help in organizing its industrial production.

- For Professor Doppel
  - Further development of the "uranium-heavy water" method for producing plutonium-239.[79]

The work of German specialists was organized and supervised by Directorate #9 of the People's Commissariat of Internal Affairs (as was mentioned above, Directorate #9 was later transferred to the PGU). Two new institutes were established for the Germans in and near the city of Sukhumi (Georgia). "Institute A" was established in Sukhumi at

[76] *Atomnii Proekt SSSR*, 47, 661, 662; A. K. Kruglov, O Pervykh V Nashei Strrane Yadernnykh Reaktorah S Tyazheloi Vodoi, "*Sozdanie...*," 292, 293, 294.
[77] A. K. Kruglov, "*Kak Sozdavalas...*," 224.
[78] A. K. Kruglov, "*Kak Sozdavalas...*," 163, 164.
[79] *Atomnii Proekt SSSR*. 22, 23.

the sanatorium (resort complex) "Sinop;" its director was Professor M. Ardenne. "Institute G," under the direction of Professor H. Hertz, was established at the sanatorium "Agudzery," near Sukhumi.

Institute A had to develop the following:

- Electromagnetic methods of uranium isotope separation: managed by M. Ardenne;
- Methods of producing diffusion baffle-plates: managed by P. Thiessen;
- Molecular methods of uranium isotope separation: managed by M. Steinbeck

The research of Institute G was organized along these lines:

- Separation of isotopes through gaseous diffusion in a flow of inert gas: managed by H. Hertz;
- Development of condensing pumps: managed by Mullenford;
- Development of the theory of stability and control of a diffusion cascade: managed by H. Barwich;
- Construction of mass-spectrometer for the determination of the isotopic structure of uranium: managed by V. Shutze;
- Development of ceramic diffusion baffle-plates for filters: managed by R. Rihmann.

German specialists also worked on other uranium research projects. In 1946-1947, laboratory V was established in the Kaluga province under the leadership of Professor R. Poze. During 1946-1953 he was one of the scientific managers developing nuclear reactors using low-enriched uranium. Twenty-three German specialists worked in this laboratory under Poze's leadership and that of noted Soviet physicist A. Leipunski. In the sanatorium "Sungul" near the city of Kasli (Chelyabinsk province), Laboratory B was established for German and some Soviet specialists. The director of Laboratory B was A. S. Uralets. German scientists K. Zimmer, G. Born, A. Kach, and others worked at this laboratory. In addition to Institutes A and G, and Laboratories V and B, separate groups of German specialists worked at Plant #12 (N. Riehl and P. Thissen), at NII-9 (M. Volmer and R. Doppel), and at Laboratory #2 (I. Shetelmeister).

A number of German scientists won high Soviet government decorations for their work. Doctor N. Reihl became a Hero of Socialist Labor--the highest civilian decoration in the Soviet Union--for his work in the technology of producing pure metallic uranium; he also won the prestigious Stalin prize. Stalin prizes were also awarded to Doctors G. Wirts (twice) and V. Shutze.

In 1953, the German specialists were relieved of their duties and returned to Germany.[80]

It is important to point out that despite their many contributions, German specialists were not engaged in the most secret work, the actual design and construction of nuclear weapons, which was going on at Arzamas-16 and Sverdlovsk-45.

By December 1946, Kurchatov got the uranium and graphite he needed and research reactor F-1 was completed. The reactor was loaded with 45.07 tons of uranium

[80] A. K. Kruglov. "*Kak Sozdavalas…*," 165, 166, 167.

(30,642 separate items) and approximately 400 tons of graphite.[81] On December 25, 1946 Kurchatov started the reactor and achieved a self-sustaining nuclear reaction. This was a great accomplishment. For the first time on the European continent a self-sustaining nuclear chain reaction was achieved--in Moscow on December 25, 1946. Moreover, it was the first step leading to production of plutonium. Achieving a chain reaction in this uranium reactor made a great impression on all participants in the nuclear project. It became obvious that an atomic bomb could be developed. Mikhail Pervukhin wrote in his memoirs: "Starting up of the reactor instilled confidence in all scientists, engineers, and designers who worked on the nuclear problem. It confirmed that we were on the correct course… After that all efforts went on faster and with better results."[82]

The development and operation of reactor F-1 was a tremendous achievement for Soviet science and technology. Experiments conducted at this reactor opened up the industrialization of nuclear energy in the Soviet Union: the sizes and parameters of industrial reactors were determined, along with their operating characteristics and optimal construction; it allowed study of problems of management, control, and facilities needed for protection from radiation.[83] The research carried out on this reactor was of critical importance for future developments.

However, on Stalin's orders, this great achievement was kept top secret. Nobody outside the country was to know that the Soviet Union was able to produce plutonium and was close to creation of its own nuclear weapon. Stalin did not want "foreign intelligence to nose out this Soviet achievement."[84]

Meanwhile, Combine #6 had started prospecting, extracting, and processing domestic uranium. The Combine had to work on a vast expanse, which covered the territories of three union republics, Tadjik, Uzbek, and Kirghiz. The uranium deposits within these territories at the time were far from well prospected and investigated, but nevertheless they became the initial base of Combine #6's activities. By July 1946, Combine #6 included five separate mine directorates, two experimental plants, a research laboratory, a power station, and a mechanical repair plant. The territorial head office of the Combine was located at Leninabad (Tadjik republic). The mine directorates were located 40 to 450 km from Leninabad.[85]

Colonel B. N. Chirkov wrote in his memoir that Stalin talked to him in connection with his appointment as director of Combine #6. Stalin stressed the outstanding importance of mining uranium for the development of the atomic bomb. As Chirkov wrote, Stalin told him: "Americans expect that we will have an atomic bomb after 10-15 years and they have built their strategy on it. They only have a few atomic bombs now, but when they arm their Air Force with atomic bombs they will want to dictate their conditions to us. It would take them about five years.[86] By that time we should have our

[81] A. K. Kruglov, Ot Opytnogo Reaktora F-1 V Laboratorii #2 K Pervomy Promyshlennomu Reaktoru V Chelyabinske-40 – Kombinat #817, "*Sozdanie…,*" 70.
[82] A. M. Petrosy'ants, Reshenie Yadernoi Problemy V 1943-1946 gg., "*Sozdanie…,*" 66.
[83] *Atomnaya Otrasl Rossii.* 58.
[84] A. M. Petrosy'ants, Reshenie Yadernoi Problemy V 1943-1946 gg., "*Sozdanie…,*" 59.
[85] V. I. Vetrov, V. V. Krotkov, V. V. Kunichenko, Sozdznie Predproyatii Po Dobyche I Pererabotke Uranovikh Rud, "*Sozdanie…,*" 180, 181.
[86] It is interesting to admit that Stalin's estimate was practically accurate. At the end of 1945 the United States had only 2 bombs, in July 1946 – 9, in July 1947 – 13, in 1948 – 50. In a year, after production of atomic bombs was intensified, the United States had 250 bombs. [Herken G. *The Winning Weapon*. N.Y.,

own atomic bomb. Comrade Kurchatov assured the Politburo that this period is realistic if he could have uranium. For scientists, engineers, and for you Comrade Chirkov this task in importance and responsibility is equal to a wartime effort. You will get all assistance and will be granted with all the powers you need."[87]

The First Directorate, the Combine #6 director, and his apparatus had to organize in the shortest possible time the production of high-quality uranium concentrates and ensure that the quantity increased rapidly. That called for new methods of prospecting for uranium ores and new technologies for extracting and processing uranium. Mines and plants had to be equipped with modern machinery and find and train a high-quality labor force. In 1947, four new plants started production. As a result, by the end of 1947 the production capacity of seven uranium plants was 605 tons of uranium ore per day. During 1947, Combine #6 processed 176,600 tons of uranium ore and produced 66 tons of uranium in 40% concentrate. In 1948, the Combine extracted 251,400 tons of uranium ore and produced 135.7 tons of uranium; in 1949 – 407,500 tons of ore and 200.3 tons of uranium; in 1950 – 588,400 tons of ore and 258.1 tons of uranium. By the beginning of 1950, Combine #6 employed more then 18,000 people.[88]

The organization of enterprises for mining and processing of uranium ores outside of the Soviet Union was started by concluding bi-lateral agreements between the Soviet government and the governments of East Germany, Czechoslovakia, Bulgaria, and Poland. These enterprises had different forms, but all of them were established with the aid of the Soviet Union. These enterprises supplied large quantities of raw materials for the Soviet nuclear industry in the initial years. In 1946, the Soviet Union got 60.3 tons of metal in marketable ores from these countries, in 1947 – 209 tons, in 1948 – 446.9 tons, in 1949 – 978.5 tons, in 1950 – 1623.2 tons.[89]

As a result, the emerging Soviet nuclear industry got uranium in sufficient quantities to sustain the research efforts and to start development of industrial reactors for producing plutonium. The Soviet Union eventually created the world's most powerful uranium industry. After the collapse of the Soviet Union, Russia found itself with vast reserves. In 1991, Russia had 200,000 tons of uranium in storage. Only 25% of the Soviet Union's confirmed deposits of uranium ore were within the territory of Russia, and most of that in locations that were difficult to access. Even so, in 1994 all 2,800 tons of uranium extracted in Russia were exported, which amounted to 12% of the world's market--internal needs were covered entirely from storage.[90]

In December 1949, the Council of Ministers removed the First Directorate from the First Chief Directorate and made it an independent Second Chief Directorate of the Council of Ministers. Within the Second Chief Directorate, a First Directorate was established for managing the domestic uranium base and a Department of Foreign Objects was established for managing the development of the uranium base in the

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1980, 343. Quoted in: V. L.Malkov, "*Manhettenski Proekt.,*" 193]. But in the Fall 1949 the Soviet Union exploded its first atomic device.

[87] A. K. Kruglov, "*Kak Sozdavalas…*," 254, 256.

[88] V. I. Vetrov, V. V. Krotkov, V. V. Kunichenko, Sozdanie Predpriyatii Po Dobyche I Pererabotke Uranovikh Rud, "*Sozdanie…,*" 187, 188, 189, 191.

[89] V. I. Vetrov, V. V. Krotkov, V. V. Kunichenko, Sozdanie Predpriyatii Po Dobyche I Pererabotke Uranovikh Rud, "*Sozdanie…,*" 192.

[90] *Atomnaya Otrasl Rossii.* 144.

countries of Central and Eastern Europe. From 1949-1953, Peter Antropov was Director of the Second Chief Directorate.[91]

From September 5-19, 1945, the Technological Council of the Special Committee decided that the most important element for development and production of nuclear weapons was obtaining plutonium from uranium-graphite reactors. As was mentioned above, Kurchatov believed that plutonium would be used in the first atomic bomb, and he paid special attention to the production of plutonium. He understood that plutonium could be produced from highly enriched uranium, and he made all efforts he could to develop other methods of producing highly enriched uranium: gas diffusion, electromagnetic separation, and centrifugal technology.[92]

Production of huge quantities of plutonium and highly enriched uranium for the atomic bomb required the establishment a powerful industry with industrial reactors and other industrial facilities. Decisions to start construction of the uranium industry were made by the Government. In March 1946, the decision was made to build Plant #813 (Sverdlovsk-44) for producing uranium-235, and in September of that year the decision to build Plant #817 (Chelyabinsk-40) for producing plutonium.

Most of all, the new industry needed industrial reactors. It is interesting to observe that the design of the first industrial reactor began on Kurchatov's instruction in March 1946, even before the F-1 research reactor was completed. N. A. Dollezhal, Director of NIIKhMMASH (Research Institute of Chemical Machine-Building), was appointed chief designer of the first industrial reactor. With NIIKhMMASH, the following institutes and design bureaus participated in the project: Proektstalkonstructsia (Design Bureau of Steel Constructions), the Design Bureau of the Ministry of the Aircraft Industry, the Institute of Aviation Materials, and the Institute of Physical Chemistry of the Academy of Sciences. Igor Kurchatov performed general scientific leadership and control. Thanks to the efforts of a large group of specialists, a reliable design was established for an industrial reactor, with all the necessary systems for control and management of nuclear chain reactions.

Construction of Plant #817, which later became Combine #817, was started in 1946. At Combine #817, the first industrial uranium-graphite reactor "A" was built, along with radiochemical Plant "B" for isolating plutonium from uranium irradiated in the reactor and "Plant V" for producing nuclear bomb parts from plutonium (nuclear cartridges). A power station, repair plant, and residential area--the city Chelyabinsk-40--were also built.[93]

The size of the construction effort at Combine #817 was enormous. The facilities of Combine #817 and the city Cheliabinsk-40 were constructed by civilian and military workers and large numbers of inmates brought from different prison camps. All together about 45,000 people worked at the construction of the Combine in 1947-1948. The majority of construction workers consisted of tens of thousands of prisoners. PGU Director Vannikov and his deputies Zavenyagin and Komarovski executed general

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[91] V.I. Vetrov, V. V. Krotkov, V. V. Kunichenko, Sozdznie Predpriyatii Po Dobyche I Pererabotke Uranovikh Rud, "*Sozdanie...,*" 180; Kratkie Biograficheskie Dannye, "*Sozdanie...,*" 391.
[92] *Atomnaya Otrasl Rossii.* 146, 147.
[93] A. K. Kruglov, Ot Opytnogo Reaktora F-1 V Laboratorii #2 K Pervomu Promyshlennomu Yadrenomu Reaktoru V Tchelyabuinske-40 – Kombinat #817, "*Sozdanie...,*" 68, 80.

management of the construction personally. On July 10, 1947, Ephim Slavski[94] was appointed Director of Combine #817 and Kurchatov was appointed the Combine's scientific supervisor. In November 1947, General Boris Muzrukov was appointed Director of the Combine.[95] Slavski was appointed Chief Engineer of the Combine, and held this position to the end of 1949.[96]

Construction of reactor "A" was so important that Vannikov and Kurchatov lived close to the construction site during the period of installation and initial operation of the reactor (more than a year). Beria regularly visited the construction. Pervukhin and other representatives of the Special Committee and PGU also regularly visited the construction site, controlling the construction progress, deliveries of equipment, and progress of the installation. The reactor was started in June 1948, and on June 22, 1948 the reactor was brought up to its design capacity of 100 MWt.[97] However, after a number of breakdowns and resulting stoppages, the reactor was shut down for major repairs in January 1949. The reactor was re-started at the end of March 1949, from which date it operated for nearly 40 years producing plutonium for nuclear weapons. Reactor "A" was finally shut down on June 16, 1987.[98]

Later more powerful, 300 MWt, uranium-graphite reactors of the same type, were designed and built. The following reactors were built at Combine #817: "AB-1" in 1950, "AB-2" in 1951, "AB-3" in 1952. They were also built at Combine #816 ("I-1" in 1950) and at Combine #815 (an even more powerful "AD" type in 1958).[99]

Another major project of Combine #817 was Radio Chemical Plant "B." The plutonium produced in a nuclear reactor had to be separated from uranium and highly radioactive fission products. At Plant "B," uranium blocks had to be dissolved, the multiple highly radioactive fission products had to be separated from uranium and plutonium, and concentrated plutonium solutions had to be produced. Then, plutonium solutions had to be delivered to Chemical Metallurgical "Plant V" for producing metallic plutonium for the atomic bomb. Construction of Plant "B" was started in December 1946. The technology for Plant "B" was developed at the Radium Institute (RIAN) under the management of the Institute's Director, Academician V. G. Khlopin. The Leningrad Design Institute (GSPI-11) produced the design of the plant. Machinery, equipment, tools, and instruments for Plant "B" were produced by many plants and research institutes all around the country. The construction of the plant was under permanent control of the Special Committee, PGU, scientific supervisor of the problem, and Combine's management. Plant "B" began operation at the end of 1948. Their first final product was delivered in February 1949.[100] It worth noting that it is very difficult to produce plutonium. From the uranium taken from the reactor for radio-chemical processing, only

[94] From 1946 Slavski was PGU Deputy Director, in 1957-1986 Minister of Medium Machine Building (it was a code name for the Ministry, which supervised nuclear industry). Kratkie Biograficheskie Dannye, *"Sozdanie...,"* 428.

[95] From 1939-1947 Muzrukov was Director of Ural Machine Building Plant, the biggest plant in the Soviet Union, in 1947-1953 he was Director of Combine #817, in 1953-1955 he was Director of Chief Directorate #4 of the Ministry of Medium Machine Building. Kratkie Biograficheskie Dannye, *"Sozdanie...,"* 417.

[96] A. K. Kruglov, *"Kak Sozdavalas...,"* 61, 62, 63.

[97] A. K. Kruglov, Ot Opytnogo Reaktora F-1 V Laboratorii #2 K Pervomu Promyshlennomu Reaktoru V Chelyabinske-40 -- Kombinat #817, *"Sozdanie...,"* 83.

[98] A. K. Kruglov, *"Kak Sozdavalas...,"* 72, 74, 84.

[99] *Atomnaya Otrasl Rossii.* 60.

[100] A. K. Kruglov *"Kak Sozdavalas...,"* 93, 95, 96, 97, 98.

0.01% was isolated as plutonium. Moreover, huge quantities of acids and reagents were also needed.[101] According to approximate estimates, the processing of 1 ton of uranium blocks required the following additional materials[102]:

Nitric acid 65% -- 11.6 tons
Sodium acetate 58% -- 11.0 tons
Caustic soda -- 2.75 tons
Hydrofluoric acid 40% --0.46 tons
Water technologically clean -- 56 tons
Water for cooling -- 2,000 tons
Steam -- 50 tons.

The final enterprise of Combine #817 was "Plant V." Super pure metallic plutonium was needed for nuclear explosives, and "Plant V" was built for producing it. The plant was built at the railway station Tatysh not far from the city Kyshtym. Technology for the plant was developed in NII#9, where a special Department V was created. Department V was headed by Academician Andrei A. Bochvar (later Bochvar became Director of NII #9).[103] Department V included 3 laboratories:

- Radio Chemical, headed by Academician Ilya I. Chernyaev;
- Metallurgical, headed by Professor Anton N. Volski ;
- Metal-working, headed by Professor Aleksandr S. Zaymovski.

After research reactor F-1 was started, research on characteristics of plutonium was undertaken. By the year 1947 Installation #5 was built at NII #9, which was used by specialists in radiochemistry for developing the technology for isolation of the first milligrams of plutonium from uranium blocks irradiated in the reactor.[104]

The first stage of the development of "Plant V" was the creation of the research-industrial enterprise for developing the technology for producing the metallic plutonium and uranium-235. This research-industrial enterprise received the first finished product from "Plant B" on February 26, 1949. In April 1949 "Plant V" started production of components from plutonium, under the scientific management of A. A. Bochvar and A. C. Zaimovski. The first small piece of metallic plutonium, 8.7 grams, produced on April 14, 1949, was sent to Igor Kurchatov for further research in Laboratory #2.[105]

The first shops were finished at "Plant V" in the second part of 1948. In the first part of 1949, Combine #817 produced the needed quantities of plutonium and "Plant V" worked out the technology for producing the plutonium charge for the atomic bomb. At the beginning of August 1949, "Plant V" produced the plutonium hemispheres used in the first Soviet atomic device, which was detonated at Semipalatinsk on August 29, 1949.[106]

[101] A. K. Kruglov, Pervii Radiokhimicheski Zavod Kombinata #817 Po Vydeleniu Plutonia Dlay Yadernoi Bomby, "*Sozdanie...,*" 112.
[102] A. K. Kruglov, Pervii Radiokhimicheski Zavod Kombinata # 817 Po Vydeleniu Plutonia Dlay Yadernoi Bomby, "*Sozdanie...,*" 98.
[103] A. K. Kruglov, Zavod Po Polucheniu Metallicheskogo Plutonia I Detalei Iz Nego Dlay Pervoi Plutonievoi Bomby, "*Sozdanie...,*" 124.
[104] A. K. Kruglov, Zavod Po Polucheniu Metallicheskogo Plutonia I Detalei Iz Nego Dlay Pervoi Plutonievoi Bomby, "*Sozdanie...,*" 121.
[105] *Atomnaya Otrasl Rossii*, 61.
[106] A. K. Kruglov, Zavod Po Polucheniu Metallicheskogo Plutonia I Detalei Iz Nego Dlay Pervoi Plutonievoi Bomby, "*Sozdanie...,*" 137, 141.

It is worth mentioning that on Kurchatov's initiative physical and radiochemical laboratories were built for conducting research at Combine #817. Later the central laboratory was built, which worked on refining technology used in the Combine's plants and shops and conducted research on the level of the leading research institutes.[107] Later Combine #816 (Tomsk-7) and Combine #815 (Krasnoyarsk-26) were built in Siberia with industrial reactors and radio-chemical plants. Krasnoyarsk-26 with 3 reactors was located inside granite rock 200 meters below ground for protection from a nuclear explosion.[108] Throughout its years of operation, Combine #817 produced about 30 tons of nuclear weapons-grade plutonium, Combine #816 produced about 70 tons, and Combine #815 produced about 45 tons.[109]

The unique technology of the diffusion plants was de-classified only in 1995. It is interesting to observe that the technical complexities of diffusion technology were so demanding that, after the United States, only 3 industrial countries were able to master it: the Soviet Union in 1949, Great Britain in 1956, and France in 1967.[110]

Highly enriched uranium, from which plutonium was separated, was also a potential fuel for an atomic bomb. The concept of using highly enriched uranium in atomic bombs was established by American scientists. Their intensive research and development, which started in 1940, was crowned by construction of a gaseous diffusion plant at Oak Ridge, Tennessee in the spring of 1945. The American atomic bomb which destroyed Hiroshima was made from highly enriched uranium.

In the Soviet Union, research on separation of uranium isotopes in gaseous form was started at Laboratory #2 when it was established in 1943. In 1944, Academician L. Artsimovich was appointed supervisor of electromagnetic methods of uranium isotope separation. In 1945 Isaak Kikoin supervised research on separation of uranium isotopes using diffusion methods. From November 1945, the work was conducted with equipment brought from Germany.[111]

At the end of 1945, the Soviet Union obtained and translated the report "Atomic Energy for Military Purposes," the official American report on the development of the atomic bomb (written by Henry D. Smyth and everywhere called simply the "Smyth Report"). From it, Soviet physicists were able to study the American experience. The report outlined the scale of the effort and the technical requirements for the extremely complex machinery and equipment. The Smyth Report described, among other things, the industrial technology for producing highly enriched uranium for military purposes using the gaseous diffusion method. Thanks to the Smyth Report, the gaseous diffusion method of enriching uranium was selected as the basic Soviet method.[112] The technical requirements for some items of equipment were extremely difficult to meet. It was obvious, Soviet specialists believed, that in permitting the Smyth Report to be published,

[107] A. K. Kruglov, Ot Opytnogo Reaktora F-1 V Laboratorii #2 K Pervomu Promyshlennomu Yadernomu Reaktoru V Chelyabinske-40 – Kombinat # 817, "*Sozdanie...*," 82.
[108] *Atomnaya Otrasl Rossii.* 149; *Atomnii Proekt SSSR.* 666.
[109] *Atomnaya Otrasl Rossii.* 150.
[110] *Atomnaya Otrasl Rossii.* 156, 157.
[111] A. K. Kruglov, "Kak Sozdavalas...," 163; *Atomnaya Otrasl Rossii.* 150.
[112] *Atomnaya Otrasl Rossii.* 151.

the Americans thought that other countries would not be able to develop the necessary gas diffusion equipment and technology.[113]

The other source of information about American achievements was reports from Soviet intelligence. As is now known, intelligence supplied Soviet physicists with an abundance of information. For example, in a memorandum of July 3, 1943 Igor Kurchatov wrote that he analyzed 237 reports from the United States, among them were 29 reports devoted to separation of uranium isotopes with gaseous diffusion (which according to Kurchatov's estimate was the basic method in the United States). Additionally, he read:

18 reports on methods of separation of isotopes with centrifuges

32 reports on the problem of uranium-heavy water mixture

29 reports on uranium-graphite reactors

55 reports on the chemistry of uranium, which contained data on producing pure metallic uranium

10 reports on development of the bomb from uranium-235

14 reports on problems of plutonium and neptunium.[114]

The Smyth Report and the materials supplied by intelligence helped Soviet scientists decide on the equipment and technology needed for using gaseous diffusion for uranium isotope separation. The Americans had proven that it worked. However, the tremendous problems of how to produce the most complex machinery and equipment, how to master the most complex technology, how to prepare the personnel to be able to use it--these had to be solved independently by Soviet scientists, designers, and engineers. The most complex parts of the machinery and equipment were gaseous-diffusion filters for separating uranium isotopes. The technical parameters for the filters were worked out at Laboratory #2: the filters should have widths of 0.8-1.0 millimeters and pores of 2-4 microns (about 1 million pores per square centimeter of filter surface). In December 1945, a closed competition was announced for the development and production of these diffusion filters. Nine institutions participated in the competition. Finally these filters were approved for fabrication.[115] Simultaneously, construction of a gaseous diffusion plant was begun.

The plant to produce highly enriched uranium through gaseous diffusion was located in the Urals at the town of Verkhne-Neivinsk, about 50 kilometers from the city of Sverdlovsk. The plant was designated "Plant 813," later "Combine 813." Construction started in December 1945 in the most difficult conditions. In the first years of construction, workers lived in wooden barracks. A barracks had bunk beds and housed about 150 men. From the beginning there was practically no construction machinery and all tasks were done by hand. The deliveries of construction machinery did not start until 1947, but most of it did not arrive until 1948 and 1949. Workers had their daily quotas of output, and, of course, over fulfillment of the planned amount was specifically encouraged. For example, a prisoner (7,000 prisoners worked at the construction site)

[113] A. M. Petrosy'ants, K Istorii Polucheniya Visokoobagashchennogo Urana Na Kombinate #813, "*Sozdanie...*," 252, 253.

[114] A. K. Kruglov, O Pervikh V Nashei Strane Yadernykh Reaktorakh S Tyazheloi Vodoi, "*Sozdanie...*," 290.

[115] *Atomnaya Otrasl Rossii.* 151, 152.

who over fulfilled his daily rate by 151% was rewarded by shortening his prison term: that day counted for 3 days of imprisonment.[116] Despite the challenging and complicated technical requirements, gaseous diffusion technology was developed and then mastered. This achievement was due to the efforts of a large group of scientists, designers, and engineers under the leadership of Isaak Kikoin (full member of the Academy of Sciences from 1953, twice Hero of the Socialist Labor).[117]

Plant D-1, the first plant of "Combine 813," had to be completed in 1949. Plant D-1 had 6260 segments connected in strict sequence in 56 cascades. All these elements had to work continuously without interruption. In 1948 the first cascades of plant D-1 were put into operation, but there was trouble from the very beginning. Mechanisms broke down and the level of gas decomposition in the cascades was intolerably high. As a result, there was practically no flow of highly enriched uranium gas to the final cascades. Kikoin and his colleagues were struggling trying to find solutions to these difficulties. At one point they decided to consult with some of the German specialists who worked in the Soviet Union. The Germans came to the plant and Kikoin advised them on what was being done and problems which were being encountered. The German specialists spent a couple of days looking through the plant's shops and studying the mechanisms and equipment. After that, the Germans stated that they were astounded with what they saw, with the huge scale and high technical level. In Germany they could only dream about something similar. So, Germans could not help.[118]

Soon after that, Lavrntii Beria came to the plant. After familiarizing himself with the situation, he met with a small group of specialists engaged in the technology and operation of the plant. Beria listened to Kikoin and a number of others who reported on what was done and on the difficulties they encountered. At the end Beria said (there were no minutes, but the substance was crystal clear): "You've done a lot. The country, being in a very difficult situation after the war, gave you all you asked for. And now we have a right to expect that you will fulfill your task. In short, I give you three months to finish everything, and if you do not do what must be done, you will have only yourselves to blame. And I warn you now: 'prepare rusks' ('prepare rusks' meant -- be prepared to end up in prison)." All present understood that if in three months the plant did not start producing highly enriched uranium, they all might be sent away to prison camps. They also understood that without the plant the country would not have nuclear weapons. They also understood that Beria was personally responsible to Stalin for development of nuclear weapons and was afraid for his position, for his life.[119]

Before his departure from the plant, Beria arranged consultations with prominent chemists and physical-chemists. Their united efforts brought about a number of proposals. As a result, some mechanisms were substituted with different ones, new electric motors were installed, a shop was built to produce dry air, and so on. As a result, Plant D-1 had 56 cascades with 7040 mechanisms. But in 1948, Combine 813 could

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[116] A. M. Petrosy'ants, K Istorii Poluchenia Vysokoobogashchennogo Urana Na Kombinate # 813, "*Sozdanie...*," 249, 250.
[117] A. M. Petrosy'ants, K Istorii Poluchenia Vbysokoobogashchennogo Urana Na Kombinate #813, "*Sozdanie...*," 264; Kratkie Biograficheskie Dannye, "*Sozdanie...*," 411.
[118] A. M. Petrosy'ants, K Istorii Poluchenia Vysokoobogashchennogo Urana Na Kombinate # 813, "*Sozdanie...*," 278.
[119] A. M. Petrosy'ants, K Istorii Poluchenia Vysokoobogashchennogo Urana Na Kombinate # 813, "*Sozdanie...*," 278, 279.

produce uranium enriched to only 75% uranium-235. However, the second atomic bomb needed uranium enriched to 94%.[120]

The problem was solved with the help of Plant #418, which had been built for electromagnetic separation of highly enriched uranium. The plant was built in the city of Lesnoi in the Sverdlovsk province. Plant #418 had a gigantic electromagnet for separating isotopes of uranium. The mass of the main electromagnet was 6,000 tons (by comparison, the cyclotron magnet at Laboratory #2 was only 75 tons). The 75%-enriched uranium produced at Plant #813 was taken to plant #418 and subsequently enriched to more than 90%. This is how the uranium was produced for use in the second Soviet atomic bomb, which was tested in 1951.[121]

The electromagnetic separation method never became the basic method of producing highly enriched uranium because of its low productivity, high losses of uranium, and high amount of energy consumption.

Plant D-1 was relatively small, its equipment was not efficient, and it consumed too much energy. But the building of plant D-1 was the first step in developing industrial diffusion technology in the Soviet Union. Later, the government decided to build the more powerful plants D-3, D-4, D-5 at Combine #813. However, Plant D-1 was in operation up to 1955 when it was dismantled as too small and economically inefficient an enterprise.[122]

In summary, during all the time of their operation, the four Soviet combines produced about 1,200 tons of weapons-grade uranium. From that, some 500 tons were removed from dismantled nuclear warheads and sold to the United States as fuel for nuclear power stations (with deliveries over a 20-year period). Soviet production of new weapons uranium was terminated in 1987.[123]

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[120] A. M. Petrosy'ants, K Istorii Poluchenia Vysokoobogashchennogo Urana Na Kombinate # 813, "*Sozdanie...*," 279, 281, 282.
[121] A. M. Petrosy'ants, K Istorii Poluchenia Vysokoobogashchennogo Urana Na Kombinate # 813, "*Sozdanie...*," 282, 283, 284.
[122] *Atomnaya Otrasl Rossii*, 147; *Atomnii Proekt SSSR*, 666.
[123] *Atomnaya Otrasl Rossii*, 164.

4. BUILDING THE ATOMIC BOMB

By the beginning of 1946, in the course of the fast expansion of nuclear weapon research, it became more and more evident that the atomic bomb project needed a special research and development center. At the time the leading research center of the nuclear project was Laboratory #2 in Moscow. Besides Laboratory #2, the Institute of Chemical Physics of the Academy, NII-6 (NII – Scientific Research Institute), and NII-504 of the People's Commissariat of Munitions; NII-88 of the People's Commissariat of Armaments; and a number of other organizations were engaged in the effort to create the atomic bomb.[124] In addition to these, a tremendous number of research institutes, design bureaus, and industrial enterprises participated in the project. But a special center was needed to perform the most important research, development, construction, and manufacturing of the prototype atomic bombs. It needed to be a large-scale, complex research institute with different laboratories, appropriate experimental plants, and testing areas. The decision was made to attach the new center to Laboratory #2.

On April 9, 1946, the Council of Ministers adopted a top secret decree entitled "Problems of Laboratory #2," which ordered the following:

1. Reorganize section #6 of Laboratory #2 of the Academy of Sciences into a Konstruktorskoye Buro (design bureau) attached to the Laboratory #2 for development of the design and manufacturing of experimental types of rocket engines. (In this and other Soviet documents "Reaktivnii dvigatel" [Rocket engine] was a code name for the atomic bomb.)
2. This design bureau from now on will be named Konstruktorskoye Buro #11 (in its Russian abbreviation, KB-11), attached to Laboratory #2.
3. To appoint:
   a. Comr. P. M. Zernov, Deputy Minister of Machine-Building for Transportation, Director of KB-11, relieving him of his duties in the Ministry.
   b. Prof. Yu. B. Khariton, Chief Designer of KB-11 for design and production of experimental rocket engines.

The decree also determined that KB-11 was to be located in the town of Sarov, on the grounds of Plant #550 of the Ministry of Machine Building for Agriculture (formerly the People's Commissariat of Munitions). The Institute of Chemical Physics of the Academy of Sciences was also to be directly engaged in the development and production of these new "rocket engines."[125]

Sarov was located about 400 km from Moscow (Stalin wanted KB-11 to be located close to Moscow, but not closer than 400 km), and 75 km from the city of Arzamas. Before the October revolution, there was a very famous monastery there and a small number of private houses. This place, with its vast forests, was sparsely populated and could house a top-secret establishment. KB-11 was given a territory of 215 square kilometers, but there were very few structures and little equipment that KB-11 could use. The laboratory, administrative, and industrial buildings all had to be constructed, machinery and equipment had to be brought in, and residential housing had to be built.

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[124] *Atomnaya Otrasl Rossii*, 55.

[125] Postanovlenie SM SSSR #805-327 ss/op "Voprosy Laboratorii #2," *Atomnii Proekt SSSR*, 429, 430.

The principal tasks of KB-11, and a plan to achieve these tasks, were determined in another top-secret decree of the Council of Ministers, dated June 21, 1946. KB-11 (Comrades Khariton and Zernov) was charged with creating, under the scientific leadership of Laboratory #2 (Academician Kurchatov) two versions of "Reaktivnii Dvigatel S" ("Rocket Engine S;" the Russian abbreviation is "RDS")[126], one using heavy fuel[127] (version S-1) and the other using light fuel[128] (version S-2). The decree specified the dates for various stages of the work and the dates when experimental prototypes of version S-1 and S-2 were to be presented for official state tests. At the request of KB-11, the decree directed the following institutions to provide spade work for the development of RDS-1 and RDS-2: Laboratory #2 of the Academy of Sciences; the Institute of Chemical Physics of the Academy; NII-6, GSKB-47 (Special State Design Bureau #47), and NII-504 of the Ministry of Machine Building for Agriculture (this Ministry inherited plants and research institutes from the People's Commissariat of Munitions); KB-88 of the Ministry of Armaments; and the Design Bureau of the Kirov Plant (Chelyabinsk) of the Ministry of Machine Building for Transportation. For every organization, the decree specified the tasks, the managers, and the dates when the work was to be completed. For example:

- KB-11 had to develop the overall technical task for the design of RDS-1 and RDS-2 by July 1, 1946; develop the design of the main parts of RDS-1 and RDS-2 by July 1, 1947; and manufacture experimental models of RDS-1 and RDS-2 by September 1, 1947.
- The Institute of Chemical Physics had to establish a special theoretical department to conduct theoretical and computational analysis.
- NII-6 had to work out the principles of design and construction of "synchronous plugs" (a code name for the electro-detonator), design the composite charge for "diesel fuel" (code name for explosives), and design the firing system.
- NII-504 had to design the automatic altitude fuse and design the system for feeding the synchronous plugs.
- KB-88 had to work out the design of the "gun" and problems of synchronism.

The respective Ministers were made responsible for meeting the specified milestones by the dates fixed and they had to report their progress every month to the Special Committee.

The decree gave KB-11 permission to organize in its structure the following laboratories: Laboratory #1 (Fuel), Laboratory #2 (Radiology), Laboratory #3 (to study deformations), Laboratory #4 (to study effectiveness), Laboratory #5 (Physics), Laboratory #6 (Spark plugs), Laboratory #7 (Metallurgy and Manufacturing), Laboratory #8 (to study physical-mechanical characteristics of fuel), Laboratory #9 (to control quality of materials), and Laboratory #10 (Safety devices).[129]

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[126] Yu. Khariton wrote that abbreviation "RDS," which stood for "Reaktivnii Dvigatel Stalina" ("Rocket Engine of Stalin") was devised by General Makhnev, one of Beria's subordinates. Yu. B. Khariton, Yu. N. Smirnov. O Nekotorykh Mifah I Legendakh Vokrug Sovetskih Atomnogo I Vodorodnogo Proektov, *"Yulii Borisovich Khariton…,"* 173.

[127] Heavy fuel was a code name for plutonium-239.

[128] Light fuel was a code name for uranium-235.

[129] Postanovlenie SM SSSR #1286-525 ss/op "O Plane Razvertyvaniya Rabot KB-11 Laboratorii #2 AN SSSR," *Atomnii Proekt SSSR*, 434, 435, 436.

On February 17, 1947 Stalin signed the decree of the Council of Ministers, which made KB-11 a top-secret establishment.[130] Its territory became a closed zone surrounded by a fence, and it was excluded from all maps. The decree ordered strict security measures: military guards, severe control of personnel and entrance into the territory. Everybody who worked and lived there was forbidden to mention the old name of the place. In was strictly forbidden for 40 years. From the beginning the code name of KB-11 was "Object-550" and "Baza-112," later "Kremlev," then "Arzamas-75," and "Arsamas-16." From the beginning of 1946 to the 1990s the nuclear center and its residential area were effectively closed off from the world.

In the Spring of 1947 the research laboratories of KB-11 began their work and the design sub-divisions were established. KB-11 needed scientists who could study the theory of all the processes taking place in nuclear explosions--designers, engineers, and laborers who could produce the bomb and its parts. The KB-11 management specified their personnel needs and began acquiring more and more specialists. The work on the creation of the atomic bomb entered a new stage. Now it was necessary to determine the most reliable construction for the bomb and the fastest means for its development and manufacture.

After the collapse of the Soviet Union, some former Soviet intelligence officers claimed that intelligence officers, not physicists, were the "true fathers" of Soviet nuclear weapons. For example, former Lieutenant General Pavel Sudoplatov (who was released from prison after about 15 years) and Colonel Leonid Kvasnikov claimed in various publications that the Soviet atomic and hydrogen bombs were developed and manufactured thanks, principally, to materials supplied by intelligence (mostly from the Manhattan project). Their publications led to an avalanche of speculation in the mass media. This assertion came as a shock to those who participated in the development and production of nuclear weapons. From the very beginning, everything connected with nuclear weapons, especially the role played by intelligence, was top secret. Nobody outside of a very small group of the nuclear project's top managers knew the true story of the Soviet atomic and hydrogen bombs. But, secrecy was pointless after 40 years, and it became both possible and necessary to tell the truth, to set the record straight. The truth was told by the Chief Designer of Soviet nuclear weapons Academician Yu. B. Khariton.

In August 1992 in an interview published in the newspaper *Krasnaya Zvezda* (*Red Star*, the newspaper of the Soviet, later the Russian armed forces), Yulii Khariton stated: "Our first atomic bomb was a replica of the American. And I would consider any other action at that time inadmissible. The timing was most important: the one who has atomic weapons, dictates political conditions."[131] In an article published in December 1992 in the newspaper *Izvestia*, Khariton again recognized that for the first atomic bomb Soviet physicists used an American design supplied by Soviet intelligence.[132] In this article Khariton described the achievements of Soviet physicists in nuclear research and frankly acknowledged that the construction of the first Soviet atomic bomb used an American design. In another article Khariton and Smirnov wrote: "The sufficiently detailed scheme and description of the first bomb tested by the Americans, which we got thanks to Klaus

[130] Postanovlenie SM SSSR #297-130 ss/op "O Merakh Obespechniya Ohrany Obekta #550," *Atomnii Proekt SSSR*. 458, 459, 460.
[131] *Krasnaya Zvezda*. August 11, 1992.
[132] Yadernoye Oruzie SSSR: Prishlo Is Ameriki Ili Sozdano Samostoyatelno. "*Izvestia*" December 8, 1992.

Fuchs and Soviet intelligence, was used for the construction of the first Soviet atomic bomb. Our scientists got these materials in the second part of 1945. When specialists at Arsamas-16 established that the information was authentic (it required a large amount of experimental research and calculations), the decision was made to use the already tested, workable American scheme for the first explosion. Taking into consideration national interests at a time of highly tense relations between the USSR and the USA, and the responsibility of scientists for the success of the first test, any other decision would have been intolerable and simply flippant. Information about the data supplied by intelligence and the decision which was made were top secret."[133]

A young and very talented German theoretical physicist, Klaus Fuchs was a communist. At the beginning of 1930s he left Germany and settled in England, where he became a British subject. In 1941 he joined a nuclear weapons research group. After Hitler's Germany attacked the Soviet Union, Fuchs went to the Soviet embassy in London and said that he was participating in the development of nuclear weapons of tremendous destructive capacity. Fuchs said that he had nuclear materials at his disposal and he would like to pass these materials to the Soviet Union. Fuchs considered it intolerable that all research on nuclear weapons in Great Britain and the United States was top secret and kept from their wartime ally, the Soviet Union. Fuchs was not recruited by Soviet intelligence. He contacted Soviet intelligence officers of his own free will. Fuchs was offered money many times, but he always refused to take it, because he passed nuclear materials to the Soviet Union not for money, but on ideological grounds.

In 1944 Fuchs and his group were moved to the United States to join the American atomic bomb effort. Fuchs worked in the theoretical department at Los Alamos. He continued his contacts with Soviet agents and passed invaluable materials to them. For example, he delivered the design of the first American atomic bomb, a development in which he personally participated, and the results of the testing of this bomb. In 1946 Fuchs returned to Great Britain where he became the head of the theoretical department of the British atomic center at Harwell. From there, through 1949, he supplied Soviet intelligence officers with very important information. Fuchs was one of the main sources of intelligence information concerning nuclear weapons developments in the United States and Great Britain, but he was not the only one who supplied Soviet physicists with information on the development of nuclear weapons.

It is worth mentioning that American and British counterintelligence services were able to discover Fuchs' contacts with Soviet intelligence. Fuchs was forced to admit that he transmitted materials on the development of nuclear weapons to the Soviet Union. In 1950 a British court sentenced Fuchs to 14 years in prison. In his presentation the prosecutor stated that Fuchs "committed his criminal action not for money but on ideological motives."

However, after Fuchs was arrested and convicted, the Soviet Union officially disassociated herself from him. Commenting on the statement by British prosecutor that "Fuchs transferred atomic secrets to agents of the Soviet government," the official Soviet wire service stated that they were authorized to declare that "this statement is a gross fabrication, that Fuchs is unknown to the Soviet government and 'agents' of the Soviet

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[133] Yu. B. Khariton, Yu. N. Smirnov. O Nekotorikh Mifah I Legendakh Vokrug Sovetskih Atomnogo I Vodorodnogo Proektov, *"Yulii Borisovich Khariton…,"* 175.

government had nothing to do with Fuchs."[134] It was only after the Soviet Union collapsed that Soviet scientists were able to openly recognize Fuchs' contribution to the development of the first Soviet atomic bomb.

All intelligence information was delivered to the scientific head of the Soviet nuclear project, Igor Kurchatov. "Kurchatov," wrote Yu. B. Khariton and Yu. N. Smirnov, "from the first days took a sober view and critical approach to the materials supplied by intelligence. He doubted whether the 'material we obtained reflected the real course of research,' and was afraid that these materials could have been a 'fabrication, directed at disorientation of our science.'"[135]

All the materials supplied by intelligence were thoroughly studied and tested. Some of these materials were very useful. "It would be incorrect," wrote Khariton, "to overestimate the role of the materials supplied by intelligence in the making of the Soviet nuclear project, at the same time we give due credit to their efforts and contributions in the success of the common cause."[136]

According to a number of publications, using the American design saved Soviet scientists a year of work. In the situation which then existed, it was more than important. Stalin thought that strained relations with the United States created the very real possibility of atomic blackmail, or even atomic attack. He wanted to have atomic weapons in less than no time. It should also be mentioned that Stalin and his aids did not completely trust Soviet scientists, designers, and engineers, and did not believe in their ability to create an original atomic bomb design. They wanted the American design to be used.

Soviet scientists felt enormous responsibility for developing the bomb as quickly as possible and for the success of the first test. The consequences of failure were more than obvious. Yu. B. Khariton and Yu. N. Smirnov mentioned that Beria, according to veterans of the project who heard conversations, had a list of participants divided into groups according to their role in the project. In the case of success, all participants were to get high decorations. The group of leading scientists and managers was to be awarded the highest civilian decoration, the Hero of the Socialist Labor. The second group would get Orders of Lenin, and so on. In the case of failure, the first group was to be executed, the second group would be put in jail for 25 years, and diminishing prison terms were prepared for all others.[137]

In an article published in the newspaper "Izvestia" on July 21, 1994, Yulii Khariton and Yurii Smirnov wrote, "We assert: in the dramatic circumstances which existed at the time, the feat of Soviet intelligence played an outstanding role. It contributed to the guaranteed success of the first Soviet atomic blast, as well as to the development of the foundations of the USSR's atomic industry. But at the same time we share the official position of the Russian Foreign Intelligence Service, which recently on May 4 of this year stated: 'Atomic and, later, hydrogen weapons were created in the Soviet Union first of all thanks to country's powerful scientific, technological, and

[134] V. N. Mikhailov, A. M. Petrosy'ants, Zakluchenie, "*Sozdanie...*," 442, 443.
[135] Yu. B. Khariton, Yu. N. Smirnov, O Nekotorikh Mifah I Legendakh Vokrug Sovetskih Atomnogo I Vodorodnogo Proektov, "*Yulii Borisovich Khariton...*," 180.
[136] Yu. B. Khariton, Yu. N. Smirnov, O Nekotorikh Mifah I Legendakh Vokrug Sovetskih Atomnogo I Vodorodnogo Proektov, "*Yulii Borisovich Khariton...*," 180.
[137] Yu. B. Khariton, Yu. N. Smirnov, O Nektorikh Mifah I Legendakh Vokrug Sovetskih Atomnogo I Vodorodnogo Proektov, "*Yulii Borisovich Khariton...*,"186.

intellectual potential. The decisive contribution was made by a large group of Soviet scientists.... As to the contribution of intelligence in creation of the Soviet atomic bomb, its important, skilled work in the national interests played a subsidiary part.'"[138]

So, the American design, supplied by Fuchs, which was successfully tested, provided a blueprint for the first Soviet atomic bomb. But to produce an actual atomic bomb from that design required tremendous efforts. An atomic industry had to be created with unique and highly complex machinery and equipment, with extremely complex technology, and with highly qualified personnel. All that had to be done in a country that was devastated by the most terrible war in its history. "Scientific-technological materials, obtained by intelligence," wrote Khariton and Smirnov, "by themselves could produce nothing and do not solve any problem. They had to be brought to the appropriate ground, to worthy professionals, who had necessary scientific and industrial basis."[139]

It is understandable that even the most detailed designs and the most detailed instructions were not enough for the development and production of an atomic bomb. The materials supplied by Fuchs and others could be used only in a country that had a first-class scientific basis and powerful industrial base. Only a country that had it could develop a specialized, large-scale, versatile nuclear industry. Everything that was needed for the nuclear industry had to be created using that country's resources, that country's materials, and that country's intellect.

As was presented in the first part of this paper, the Soviet pre-war theoretical and experimental research in nuclear physics had laid a strong scientific foundation for future work on nuclear weapons. An outstanding school of world-class nuclear physicists had been established in the Soviet Union. They were ready to tackle the most complex and difficult scientific tasks of developing nuclear weapons.

The Soviet industrial base, despite war damage, had definite advantages for producing nuclear weapons. The Soviet Union had a state-owned, state-planned, state-managed, highly centralized economy. Because of that, in a totalitarian state the Soviet leadership was able to mobilize all the necessary resources – human, material, financial – for achieving their priority aims, without regard to the human sufferings, to the material losses, to the deterioration of other parts of the economy and low living standards imposed on the population. From the very beginning, the Soviet leadership set on the course of creating a powerful armed forces backed by appropriate defense industries. The defense industries had the most privileged position in the Soviet economy. They received the best machinery and equipment, the best personnel, the highest salaries and wages, and the best social services and living conditions. High Government bodies managed these defense industries. At the top of these bodies were Communist party leaders and, first of all, Stalin himself, who made all principal decisions concerning development and production of armaments and munitions. In the Soviet Union a highly militarized economy was created with a vast network of defense plants, military-oriented research institutes and design centers. In addition to that, many plants and factories engaged in civilian production were built with the aim to be easily transferred to military production in time of war.

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[138] Ulii Khariton, Urii Smirnov. Otkuda Vzaylos I Bylo Li Nam Neobhodimo Yadernoye Oruzie. *Izvestia.* July 21, 1994; V. N. Mikhailov, A. M. Petrosy'ants, Zakluchenie, "*Sozdanie...,*" 444.

[139] Yulii Khariton, Yurii Smirnov. Otkuda Vzyalos I Bylo Li Nam Heobhodimo Yadernoe Oruzhie. Esho Raz o Faktah I Domyslah, *Izvestia.* July 21, 1994.

Production of armaments and munitions expanded tremendously during the course of the war with Germany, despite war losses and destruction. More than a thousand armaments-producing plants were moved from the country's West to the East and many new plants were built; plants and factories producing civilian goods were transferred to the production of armaments and munitions. For example, by 1943, 1300 enterprises of 60 different People's Commissariats and separate Departments were producing munitions.[140] In 1943 Soviet production of armaments and munitions surpassed that of Germany, her European allies, and conquered countries.

Soviet defense industries – its industrial enterprises, research and design facilities, its managers, designers, scientists, and engineers, and its experience – were used to the full extent in the development and production of Soviet nuclear weapons. As we saw earlier, Boris Vannikov was appointed top manager of the nuclear project. Before the war he was the People's Commissar of Armaments and during the war he was the People's Commissar of Munitions. He knew the Soviet defense industries inside out and was able to engage their full potential in the development and production of nuclear weapons. Quite a number of defense industries' top managers, designers, and engineers were transferred to the nuclear project. As was mentioned earlier in this paper, many defense plants, research institutes, and design centers were transferred to the nuclear project or fulfilled specific tasks for it. The Soviet defense industries were a rock solid foundation for the nuclear project.

Intelligence information about the American plutonium bomb without a doubt permitted the Soviets to avoid a number of mistakes during development of RDS-1, to significantly shorten the development time, and to cut down expenditures on research and development. But to effectively use the intelligence information, a huge amount of theoretical and experimental work had to be conducted to verify its authenticity.

Only a very few people (Kurchatov, Khariton, and a few others) knew that a proven American prototype was used in the construction of the first Soviet atomic bomb. None of the others knew anything about it. They were getting general directives from the chief designer and had themselves substantiated their choice for this or that piece of construction. Only in the 1990s were they struck with revelation that they were following an American design. But that did not in the least diminish their input into the creation of nuclear weapons.

From the start of the development of RDS-1, there was an urgent necessity to bring about a vast program of theoretical and experimental research, development, and design work. This program could not be accomplished by the efforts of just one center.

In February 1948, the Special Committee presented to Stalin a draft decree of the Council of Ministers about a plan of work for KB-11. The Council of Ministers' decree admitted that the major components of RDS were not completed by the dates fixed in the decree of the Council of Ministers of June 21, 1946 because of its novelty and unforeseen scientific and engineering difficulties. The decree established March 1, 1949 as a last date of presentation of RDS-1 (fueled with heavy fuel, plutonium-239). For RDS-2 (fueled with light fuel, uranium-235) the date was December 1, 1949. The decree also fixed the dates for completing the major components of RDS-1 and RDS-2. The decree ordered the following enterprises to produce the components and parts: Plant #48 of the PGU; Plant #29, Plant #64, and Plant #219, OKB-25 (Special Design Bureau #25) of the

140 *Sovetski Tyl v Velikoi Otechestvennoi Voine.* (Moskva: 1974, Kniga 2), 123.

Ministry of Aircraft Industry; Plants #232 and #233, and NII-88 of the Ministry of Armaments; NII-6 and NII-582 of the Ministry of Machine Building for Agriculture; TsKB-326 (Central Design Bureau #326) and Plant #619 of the Ministry of the Communications Industry; and the Kirov Plant (Chelyabinsk) of the Ministry of Machine Building for Transportation.[141]

On June 10, 1948, the Council of Ministers issued a decree with additions to the plan of works for KB-11.[142] On the same day the Council of Ministers issued a decree, in which additional tasks were specified for work on RSD-1, RSD-2, RSD-3, RSD-4, and RSD-5 to the following institutions: Laboratory #2, the Institute of Physical Problems of the Academy of Sciences, the Mathematical Institute of the Academy, the Institute of Geophysics of the Academy, and the Institute of Physics of the Academy. The Decree contained a number of measures to ensure the fulfillment of these tasks.[143]

The first Soviet atomic bomb, RDS-1, was created under the management of Yakov Zeldovich and Yulii Khariton. They created the general theory of the action of the atomic charge, made calculations, determined the major dimensions of the nuclear charge, developed the design of a neutron trigger, and developed the design of the composite charge and explosives which ensured creation of a detonation wave. The General Designer of the first atomic bomb was Yulii Khariton; Kirill Shchelkin was his deputy.[144]

The development of the atomic bomb started with the selection of the geometrical form and design of the plutonium charge. The mass of the plutonium charge was determined in July 1948 after experiments were completed. Soviet designers had intelligence data on the design of the nuclear charge, but they did not have information on the method of detonating the charge.

KB-11 had to carry out all the necessary research for the atomic bomb with the active participation of theoreticians from the Institute of Chemical Physics. KB-11 had to produce RSD-1 and, later, RSD-2. RSD-1 had two groups of components and instruments. The first group was a ballistic frame with components that were to be installed at the plant where it was manufactured. The second group of components was to be installed at the test range, not at the plant. All components, blocks, and systems of the first group were developed at KB-11. Among the plants that manufactured components for the first group were a number of defense plants. Out of six blocks for the second group, four were developed at KB-11 and two outside of it. Only three blocks were manufactured outside of KB-11.[145]

All work on the atomic bomb at KB-11 and elsewhere was held in the strictest secrecy. Only a small number of the project's top leaders knew the whole picture. All the rest knew only their special part of the general task. As was mentioned earlier, only Igor

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[141] Postanovlenie SM SSSR #234-98 ss/op "O Plane Rabot KB-11 pri Laboratorii #2 AN SSSR" 8 fevralya 1948 g." *Atomnii Proekt SSSR*. 481- 489.

[142] Postanovlenie SM SSSR #1989-773 ss/op "O Dopolnenii Plana Rabot KB-11" 10 iunya 1948 g., *Atomnii Proekt SSSR*. 494, 495.

[143] Postanovlenie SM SSSR #1990-774 ss/op "O Dopolnitelnih Zadaniyah po Planu Spetsialnikh Nauchno-Issledovatelskih Rabot na 1948 god" 10 iunya 1948 g., *Atomnii Proekt SSSR*. 495-498.

[144] *Atomnaya Otrasl Rossii*, 165.

[145] V. N. Mikhailov, Ye. A. Negin, G. A. Tsyrkov, Organizatsiya Filiala Laboratorii #2 – KB-11 I Opytnoi Bazy Dlya Zavershaushei Stadii Sozdaniya Yadernoi Bomby V Sarove Mordovskoi ASSR, "*Sozdanie...,*" 213, 214.

Kurchatov received all the intelligence information. With special permission he passed parts of it to Khariton and a couple of other top people in the project. All closed cities where the major work was going on had code names: KB-11 (or Arsamas-16), Chelyabinsk-70, Sverdlovsk-44, Krasnoyarsk-26, Krasnoyarsk-45, Chelyabinsk-65 (before, Chelyabinsk-40), Sverdlovsk-45, Zlatoust-36, and Penza-19. Top secret decrees of the Council of Ministers, in which different Ministries, plants, research centers were ordered to produce different components for the project, contained only code numbers, not the names of the components. In these decrees words like 'atomic bomb,' 'plutonium,' and 'uranium,' were inserted in longhand, or code names were used. (The code name for the bomb was "article.") Even in top-secret reports on the results of research, code names were used for materials and components of the bomb. Individuals and groups working on this or that component did not know what the group next door was working on. Even later, during the first period of the work on a hydrogen bomb, far from all participants knew what they were really doing. Yu. B. Khariton and Yu. N. Smirnov published a really anecdotal example. "One of the managers of the KB-11 Design department," wrote Khariton and Smirnov, "on the eve of test of the first Soviet hydrogen bomb, was leaning on the bomb and saying to his colleagues 'The secrecy in our country is unimaginable! Somewhere there exists another center where the work on nuclear weapons is also going on, and we have no idea about it! Yesterday Malenkov (Prime-Minister at the time) said in his speech that a hydrogen weapon was created in our country, and we do not know where it was done and who did it!' And it happened in August 1953."[146]

By January 1949 all design problems for RSD-1 had been solved. From January to August 1949, a vast program of testing was carried out. The decision was made to explode the first atomic charge at a tower on a special range.

The test range for the experiment was located in Kazakhstan, about 170 km west of the city of Semipalatinsk. This location was a waterless plain about 20 km in diameter and surrounded by low mountains. Appropriate research facilities were built at the range, quite a number of buildings located at different places. The central object was a testing field, a 10-km radius circle divided into 14 sections. In the civilian structure sections, a number of houses were built, along with parts of an electric power line, a railway with a bridge, sections of water pipe and sewerage, an industrial building, and three mines at 10 meters, 20 meters, and 30 meters to imitate a subway. In the military sections, various weapons were located at different distances from the center: 53 airplanes of different types, 53 artillery pieces, 25 tanks and self-propelled artillery systems. For biological experiments, more then 1,500 animals were located in the appropriate section of the range. After the explosion, the condition of everything at the testing range was characterized. The power of the blast wave, the impact of the thermal flash, and the action of the ionizing radiation all had to be studied. A metal tower 37.5-m high was built at the center of the range for the nuclear charge of the RSD-1. Automatic recording devices and instruments were placed in 44 special constructions built in a number of sections. The command post for the range, structure '12-P,' was located at the eastern boundary of the test range, along with a number of buildings for storing the components of RSD-1 and for preliminary assembly of the device. Automatic controls for detonating

[146] Yu. B. Khariton, U. N. Smirnov, O Nekotorykh Mifah I Legendakh Vokrug Sovetskih Atomnogo I Vodorodnogo Proektov, *"Yulii Borisovich Khariton…,"* 174.

the atomic charge and automatic controls of all measuring instruments and equipment on the testing ground were established at the command post.[147]

On August 26, 1949, Beria came to the range. By that time two explosive charges were assembled – live and reserve – produced by experimental plants #1 and #2 of KB-11. The final assembly of the device was finished at 3:00 a.m. on August 29th, and the device was placed in the 30-m tower. By 6:00 a.m. all preparations were completed.[148] At 7 a.m. on August 29,1949, the first Soviet atomic device, a plutonium bomb, made according to the American design, was detonated. The test was a smashing success. There was general exultation at the command post. Beria embraced Kurchatov, kissed him and said: "It would have been a great misfortune, if it had not worked." Kurchatov knew very well what kind of misfortune it would have been. Then Beria became concerned whether the explosion was the same as for the American device. He called M. G. Mesheryakov, Deputy Director of Laboratory #2, who was at the observation post. Mesheryakov, at the invitation of the Americans, had been present at the tests of an American atomic bomb at Bikini Atoll in the Pacific in July 1946. Beria asked Mesheryakov: "Does it look like the American explosion? We did not make a blunder? Kurchatov is not bluffing? Everything looks exactly like an American explosion? Good! Good! So, we may report to Stalin that the test went on successfully?" And Beria immediately made a call to Stalin reporting the success of the first Soviet atomic explosion.[149]

On August 30, 1949 Beria and Kurchatov sent Stalin a report with preliminary data obtained at the test. They wrote that the bomb was designed and produced by the First Chief Directorate of the Council of Ministers under the scientific supervision of Academician Kurchatov and the Chief Designer, Professor Khariton. The explosion was of tremendous destructive and striking power. The explosion capacity was equivalent to the explosion of not less than 10,000 tons of trinitrotoloul (TNT). The report presented data on destruction by the percussive blast wave, and the impact of thermal radiation, ionizing radiation, the light flash, and so on.[150]

The creation of the Soviet atomic bomb was highly rewarded. High government decorations were awarded to a large number of scientists, managers, designers, engineers, military officers, security personnel, and workers. The top leaders got extraordinary rewards. For example, Yu. B. Khariton, the Chief Designer of the atomic bomb, became a Hero of the Socialist Labor and received a premium of 1,000,000 rubles, a ZIS-110 car (the best Soviet car at the time), and a Stalin's prize first degree. Further, a mansion and a country house with furniture and appliances were built for him at government expense. Khariton, his wife and children got the right to use rail, water, and air transportation free of charge within the Soviet Union, and Khariton's children were awarded the right to be

[147] V. N. Mikhailov, Ye. A. Negin. G. A. Tsyrkov, Podgotovka Poligona I Ispitanyia Yadernoi Bomby Pod Semipalatinskom V Kazakhstane, "*Sozdanie…,*" 230, 231.
[148] V. N. Mikhailov, Ye. A. Negin, G. A. Tsyrkov, Podgotovka Poligona I Ispytaniya Yadernoi Bomby Pod Semipalatinskom V Kazakhstane, "Sozdanie…," 242, 243.
[149] *Bomba/Zhurnalisti Studii 'Nekos.' "Russkie Sensatsii*" (Moskva: IzdAT, 1993). 34. Stanislav Pestov, *Bomba. Taini I Strasti Atomnoi Preispodnei* (Sankt-Peterburg: "Shans," 1995).307.
[150] Doklad L. P. Beria i I. V. Kurchatova I. V. Stalinu o predvaritelnih dannyh, poluchennyh pri ispytanii atomnoi bomby. 30 avgusta 1949. (Written in longhand). In: *Atomni Proekt SSSR*. 639-643.

educated in any Soviet teaching institution at government expense.[151] K. I. Shchelkin, V. I. Alferov, and N. L. Dukhov (deputies to the Chief Designer), Ya. B. Zeldovich (supervisor of development of the general theory of the atomic bomb), G. N. Flerov (supervisor of the research which determined the critical mass of the atomic charge) got practically the same awards. The difference was that they got less money, the second best cars, and no mansions, only country houses. All in all, 33 top participants in the project became Heroes of the Socialist Labor; 3 participants, B. L. Vannikov, B. G. Muzrukov, and N. L. Dukhov, got the second medal of the Hero of the Socialist Labor; 260 were awarded the Order of Lenin, the second highest government decoration; 496 were awarded the Order of Labor Red Banner; and 52 got the Order 'Mark of Honor.'[152]

The clause about education needs some explanation because education in the Soviet Union was free from grammar school to post-graduate school. This clause, according to what I've heard from my friends who used that right, was installed at the requests of the participants. Quite a few of them actually asked for it, especially those who were Jewish. The year 1949 and the following years was a period of rampant anti-Semitism in the Soviet Union, and it was practically impossible for a Jewish boy or girl to be admitted to a university or a prestigious institute. A friend showed me a document, issued to his father in accordance with this clause. The document, issued to citizen so and so, stated that the decree of the USSR Council of Ministers of October 29, 1949 awarded him the right to educate his children (the names of the children were included in the document) at government expense at all teaching institutions of the Soviet Union. Directors of all these institutions were instructed that after passing the entrance examinations these individuals should be granted unimpeded admission. "Unimpeded admission" at any university or institute was one of the most important awards for Jewish participants of the project: it ensured higher education for their children.

The first serial production versions of RDS-1 were produced at the KB-11 experimental plants in 1950. They were not delivered to the armed forces, but were disassembled and stored at KB-11.[153]

Using the American scheme for the development and production of the first Soviet atomic bomb actually delayed the work on the original Soviet design. "When Soviet scientists decided to use the American scheme for the first explosion," wrote Khariton and Smirnov, "they had to slow down for a time the development of their original and more efficient design." Nevertheless, experimental work on it was started in the spring of 1948. In 1949 L. V. Altshuller, Ye. E. Zababikhin, Ya. B. Zeldovich, and K. K. Krupnikov issued a report, which substantiated by computations and experiment that the alternative design of the nuclear charge was without doubt more advanced than the American design. This charge was successfully tested in 1951. It was the second atomic weapon test in the Soviet Union. Now models of both weapons are displayed next to one another at the Museum of Nuclear Weapons at Arzamas-16, one made from the

[151] Postanovlenie SM SSSR #5070-1944 ss/op "O nagrazhdenii I premirovanii za vydaushchiesya nauchnye otkrytiya i tekhnicheskie dostizheniya po ispolzovaniu atomnoi energii," 29 oktyabrya 1949 g., *Atomni Proekt SSSR*, 548.

[152] Postanovlenie SM SSSR #5070-1944 ss/op "O nagrazhdenii I premirovanii za vydaushchiesiya nauchnie otkrytiya i tekhnicheskie dostizheniya po ispolzovaniu atomnoi energii," 29 oktaybrya 1949 g., *Atomni Proekt SSSR*. 563-605.

[153] V. N. Mikhailov, Ye. A. Negin, G. A. Tsyrkov, Podgotovka Poligona I Ispytaniya Yadernoi Bomby Pod Semipalatinskom V Kazakhstane, "*Sozdanie...*," 248.

American design and the other from the Soviet design tested in 1951; they present a striking contrast. The bomb made according to the Soviet design was nearly two times lighter than the carbon copy of American bomb, and at the same time was two times more powerful."[154]

The second Soviet atomic bomb, RSD-2, which was also tested at the Semipalatinsk range, used highly enriched uranium. The power of RSD-2 was equivalent to 38,000 tons of TNT. A series of five atomic bombs weighing 3 tons each was produced at the experimental plant "Avangard" at Arzamas-16 and put in storage to be ready in case of war.[155] Nuclear charges were produced in Russia at four specialized plants: plant "Avangard" at Arzamas-16, the plant at Sverdlovsk-45, the plant at Penza-19, which was built in 1955, and the plant at Zlatoust-36. The materials for these nuclear charges were uranium and plutonium. About 15 kg of weapons-grade uranium or 5 kg of weapons-grade plutonium were needed for production of one nuclear cartridge. Weapons-grade uranium was produced in Russia by four combines at the cities Verkh-Neivinsk, Krasnoyarsk-45, Tomsk-7, and Angarsk. Weapons-grade plutonium was produced in Russia at Tchelyabinsk-40, Krsnoyarsk-26, and Tomsk-7. Frames and equipment for atomic cartridges were produced in Moscow at "Machine Building Plant 'Molniya.'" Nuclear cartridges were assembled at Sverdlovsk-44 and Sverdlovsk-45. In 1953 Russia had about 100 nuclear charges. The United States at that time had 1169 nuclear charges with combined power of 73 megatons.[156]

[154] Yu. B. Khariton, Yu. N. Smirnov. O Nekotorikh Mifah I Legendakh Vokrug Sovetskih Atomnogo I Vodorodnogo Proektov, *"Yulii Borisivich Khariton...,"* 176.
[155] *Atomnaya Otrasl Rossii.* 169.
[156] *Atomnaya Otrasl Rossii.* 166, 168.

5. CONCLUSION

The first Soviet atomic device was detonated only four years after the Americans exploded their first atomic bombs. It was an outstanding achievement. How was the Soviet Union able to do it? Looking back we should, in my view, recognize the following:

- The outstanding achievements in nuclear research of Soviet scientists before the war. On that foundation the scientific part of the project was developed.
- After the American bombs were exploded, the Soviet nuclear project became national priority number one and was managed from the highest government level. Because of that, the nuclear project got all the human, material, and financial resources that were needed.
- The Soviet Union, despite the destruction caused by the war with Germany, had developed an adequate industrial base, especially industries engaged in production of armaments and munitions. The plants, research and design facilities, and highly qualified managers, designers, engineers, and workers of these industries were fully used in the nuclear project.
- Despite all the difficulties, the Soviet Union was able to build a nuclear industry in a very short time, a new specialized branch of industry.
- Stalin, Beria, and their subordinates used brutal intimidation in their relations with scientists, managers, and engineers engaged in the project. Everybody knew that failure would definitely lead to imprisonment or execution.
- Materials obtained by intelligence, among other data, supplied the proven, tested design for the first bomb, which shortened the design and development time.

Soviet scientists made the most important contributions in the development of nuclear weapons. They worked in an extremely difficult situation that ruled out exchange of scientific information--in closed cities, behind tall fences and barbed wire, under conditions of severest secrecy and constant surveillance, and in constant fear of repressions. What motivated them? I believe they were motivated by the following:

- It was a scientific challenge to develop the atomic bomb, to show the Americans and the world that they could also do it.
- They thought the development of nuclear weapons was of primary importance to maintain a balance of power with the United States
- The pure scientific interest in solving the most difficult problems.
- The prestige and privileges connected with work on the nuclear project.
- Fear, fear of punishment, fear of execution or imprisonment if the work was not crowned with success.

As is well known, American experts were sure that development and production of the first Soviet atomic bomb would take much more time than it actually did. Why were the American experts mistaken? What did they not know or underestimate? I think that this error in judgment happened because the American experts:

- Underestimated Soviet achievements in pre-war nuclear research and the world-class level of leading Soviet physicists.

- Underestimated the high level of the Soviet research institutions that were engaged in the nuclear project.

- Underestimated the high level of Soviet scientists, managers, designers, engineers, and workers.

- Did not realize that the Soviet leadership was able to establish the creation of an atomic bomb as national priority #1 and subordinate to it all necessary resources, human, material, financial.

- Underestimated the ability of the Soviet command economy to concentrate all necessary resources for solving the most important problem.

- Underestimated the Soviet industrial base, especially the armaments and munitions producing industries that were elevated to new levels during the war with Germany.

- Underestimated the brutal nature of Soviet leaders, who used intimidation and fear of severe punishment in making all participants of the project work most diligently and efficiently.

6. AFTERWORD: SOME REMARKS ON THE SOVIET HYDROGEN BOMB

The first Soviet hydrogen bomb was tested on August 12, 1953. Like the second Soviet atomic bomb, RDS-2, this was an original Soviet design. The history of the development, construction, manufacture, and testing of the first Soviet hydrogen bomb deserves a full story of its own. However, some facts from its history are worth mentioning here briefly, especially incidents connected with the life and activities of a great man, one of the greatest physicists of our times – Andrei Sakharov.

The initiative for creating the hydrogen bomb in Russia belongs to I. I. Gurevich, Ya. B. Zeldovich, I. Ya. Pomeranchuk, and Yu. B. Khariton. In 1946, they put forward the idea of developing a hydrogen bomb in a special report to the Government. In June 1946, a group of theoreticians at the Institute of Chemical Physics under the leadership of Zeldovich started theoretical investigations into the possibility of using the nuclear energy produced by synthesis of light elements. [157]

The work on hydrogen weapons was activated in 1948. In June 1948, the Government Decree #189-773 instructed KB-11 to conduct, in 1949, theoretical and experimental assessments of RSD-6 – the first Soviet hydrogen bomb. This Decree instructed the Physical Institute of the Academy of Sciences (FIAN) and the Mathematical Institute of the Academy to participate in this work. The theoretical departments of these Institutes were expanded with the addition of new scientists.[158] At FIAN a special group to explore the possibilities of developing a hydrogen bomb was established in June 1948 under the direction of the noted physicist Igor Tamm. Andrei Sakharov was included in the group. Sakharov had become Tamm's graduate student in 1945; by 1948 he was a junior research associate with a Ph.D.

Professor Yurii Romanov, who was a young graduate student in Tamm's group, recalled: "Within a couple of months Sakharov put forward the fundamental concepts which determined the further direction of the project. As a fuel for the thermonuclear device, Zeldovich's group was considering liquid deuterium, possibly mixed with tritium. This design, with liquid deuterium fuel, was called 'truba' (tube, in English). Sakharov put forward his own concept: a heterogeneous construction composed of alternate layers of light elements (deuterium, tritium and their chemical compounds) and heavy elements (uranium-238); he called this concept 'sloika' (resembling a puff pastry)."[159] According to Romanov, Sakharov's concept was approved in 1950, and Sakharov moved to Arzamas-16 to further the work.

Vasili Yemelianov, who was Deputy Director of the First Chief Directorate, worked for a couple of years with this author at the Institute of World Economy and International Relations after his retirement from the nuclear project. Once he told us, a small group of colleagues at the Institute, a colorful story about Sakharov's presentation of his concept for the hydrogen bomb. According to Yemelianov's story, Sakharov, a young junior research associate, presented his theoretical concept of the hydrogen bomb to Igor Tamm. Tamm was impressed and the same evening arranged a meeting of leading physicists – Kurchatov, Kapitsa, Tamm (I definitely remember these names) and others

[157] *Atomnaya Otrasl Rossii.* 168
[158] *Atomnaya Otrasl Rossii.* 168
[159] Quoted in: Yu. B. Khariton, V. B. Adamski, U. N. Smirnov. O Sozdanii Sovetskoi Vodorodnoi (Termoyadernoi) Bomby, *"Yulii Borisovich Kharinon…,"* 198.

of the same stature. Sakharov presented his concept, and successfully answered tough questions. His concept was approved. That very evening Sakharov was made a full professor! The next day was the last day to nominate candidates for election to the Academy of Sciences. Sakharov's candidacy was presented and he became a full member of the Academy. Yemelianov's story impressed us very much. However, we later learned that the dates of some events did not correspond with those in Yemelianov's story. For instance, Sakharov presented his concept for the first time in 1948. According to Yemelianov he was elected to the Academy that very year or early the next year. In reality, Sakharov, then 32, was elected a full member of the Soviet Academy of Sciences in 1953 after the successful test of his device. Yemelianov obviously shifted two events in time, which was forgivable after many years.

From 1948, the Soviet Union simultaneously developed both the 'truba' and 'sloika' designs for the hydrogen bomb. 'Sloika' was preferred because of its obvious advantages. Only in 1954 was the decision made to terminate work on 'truba,' because it proved to be hopeless.[160]

Sakharov's 'sloika' design was used in the first Soviet hydrogen bomb, tested on August 12, 1953. The thermonuclear fuel was lithium in the form of solid chemical compound (an idea of Vitalii L. Ginzburg). The yield of this first hydrogen explosion was about 400 kt. It was the first hydrogen weapon in the world, and it was ready to be used as a transportable hydrogen bomb. [The Americans had detonated a more powerful (10-Mt) hydrogen device on Nov 1, 1952. However, the American apparatus was essentially a laboratory experiment, the size of a two-story house, not compact enough to be called a bomb.]

The successful test of the first hydrogen bomb was an outstanding pioneering achievement of Soviet physicists, especially A. D. Sakharov and V. L. Ginzburg, and also I. E. Tamm, the group leader.[161]

Sakharov worked at Arzamas-16 for nearly 20 years. For his decisive contributions to the development, production, and perfection of hydrogen weapons, Sakharov received the most prestigious Government awards: three times Hero of Socialist Labor, the highest civilian decoration; the Lenin prize, the country's highest prize; and other awards.

However, from the early 1960's, Sakharov became more and more concerned about the threat of nuclear war. In 1961 he openly criticized Khrushchev's plan to test a 100-megaton hydrogen bomb in the atmosphere. Sakharov helped to convince Khrushchev to negotiate a partial test ban treaty in 1963. Eventually Sakharov became engaged in political and humanitarian issues. In 1968 he published in the West his essay "Progress, Coexistence, and Intellectual Freedom," in which he called attention to the dangers of nuclear war, called for nuclear arms reduction, criticized dictatorial regimes, predicted and endorsed the eventual integration of socialist and capitalist systems in a form of democratic socialism, and criticized the increasing repression of Soviet dissidents. By the end of the 1960's Sakharov was discharged from nuclear weapons work for his open critique of the policies of the Communist Party leadership. He returned

[160] Yu. B. Khariton, V. B. Adamski, U.N. Smirnov, O Sozdanii Sovetskoi Vodorodnoi (Termoyadernoi) Bomby, "*Yu. B. Khariton...*," 198, 199, 200.

[161] Yu. B. Khariton, V. B. Adamski, U.N. Smirnov, O Sozdanii Sovetskoi Vodorodnoi (Termoyadernoi) Bomby, "*Yu. B. Khariton...*," 196.

to Moscow in 1969, where he once more joined the theoretical department of FIAN. From then on, Sakharov was engaged in theoretical physics research.

In 1970, Sakharov co-founded the Moscow Human Rights Committee. He defended people who were punished for their opinions and he spoke out against the incarceration of dissidents in psychiatric institutions and the denial of the right to emigrate. For his humanitarian work, Sakharov won the 1975 Nobel Peace Prize and a number of prestigious international prizes.

Eventually Andrei Sakharov, the greatest physicist and father of Soviet hydrogen bomb, became *persona non grata* for the Soviet leadership. In December 1979, he denounced the Soviet invasion of Afganistan and called for a world boycott of the 1980 Moscow Olympic Games. In January 1980, the Soviet Government stripped him of all his Government decorations and awards and exiled him and his wife to the closed city of Gorky (now Nizhni Novgorod), where they lived practically under house arrest. The communist party leadership also wanted Sakharov to be expelled from the Academy of Sciences. The matter was put on the agenda at the meeting of the Presidium of the Academy of Sciences. As it was rumored in Moscow at the time, the President of the Academy said at the meeting, "Now we have to make an unprecedented decision – to expel Andrei Sakharov from the Academy." To that, Presidium member Academician Peter Kapitsa replied, "Why say unprecedented? There was a precedent. Hitler expelled Albert Einstein from German Academy of Sciences!" To that, the President of the Academy simply said, "We will consider the next item on our agenda." The matter was closed. Sakharov was not expelled from the Academy.

In December1986, Mikhail Gorbachev released Sakharov and his wife from exile and they returned to Moscow. In 1989 Sakharov was elected to the new Soviet parliament, The Congress of People's Deputies, where he became the leader of a group of liberal deputies that advocated rapid economic reform, democratization, and the end of privileged position of the Communist Party. His decorations and awards were returned to him.